EVOLVING BUSINESS MODELS

For Renewable Energy Co-operatives

Focus on Partnerships

May 2019

About TREC

TREC Renewable Energy Co-operative is a non-profit organization that advocates for and supports the transition to 100% renewable energy. Founded in 1998, TREC built the first co-operatively owned wind turbine and founded one of the largest solar co-operatives in North America. TREC believes our energy future must involve Community Ownership by the local residents to build community resiliency and enable sustainable economic practices.

TREC works closely with others in the co-operative and environmental sectors as well as with Indigenous community groups to support their renewable energy projects. In partnership with our charitable sister organization Relay Education, we promote and support knowledge sharing, skills development and training for youth and leaders.

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We also wish to acknowledge, recognize and thank the many individuals who shared their project experiences. We can begin to understand best practices and share information between all who believe in building a renewable energy future. We thank all those individuals for sharing their perspectives and lessons learned so we can help shape effective policies and programs across Canada going forward.

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Disclaimer

The information in this report is intended to help co-operatives and potential partners in the understanding of the potential benefits and challenges in renewable energy project development. It should only be used as a supplementary guide when considering whether to devote time and resources toward developing a project. It is not a legal interpretation of any policies, programs or regulations, nor does it intend to provide detailed program and eligibility criteria. Links to government legislation, policies and programs have been provided, however the authors are not responsible for outdated information or changes that have occurred since the writing of this report.

List of Acronyms

AC	Alternating Current
BES	Battery Energy Storage
BIA	Business Improvement Area
BOMA	Building Owners and Managers Association
BTM	Behind-the-meter
CDM	Conservation and Demand-Management
CMHC	Canada Mortgage and Housing Association
DC	Direct Current
DER	Distributed Energy Resources
DG	Distributed Generation
DR	Demand Response
EDA	Electricity Distributors Association
EE	Energy Efficiency
ESI	Efficiency-related split incentives
ESPC	Energy Service Performance Contract
EV	Electric Vehicle
FIT	Feed-in Tariff
FTM	Front-of-the-meter
GA	Global Adjustment
GHG	Greenhouse Gas
HOEP	Hourly Ontario Electricity Price
HONI	Hydro One Network Inc
ICI	Industrial Conservation Initiative
IESO	Independent Electricity System Operator
kVa	Apparent Power
kW	Kilowatt
kWh	kilowatt hour
LDC	Local distribution company
LSM	Local Service Manager
MSI	Multi-tenant, multi-owner split incentives
MURB	Multi-Unit Residential Buildings
MUSH	Municipalities Universities, Schools, and Hospitals
MW	Megawatt
MWh	Megawatt Hour
NERC	North American Electric Reliability
NM	Net-Metering
NREL	National Renewable Energy Laboratory
O&M	Operations and Maintenance
OEB	Ontario Energy Board
OREC	Ottawa Renewable Energy Co-operative
PM	Property Manager
PPA	Power Purchase Agreement
PV	Photovoltaic
RE	Renewable Energy
REC	Renewable Energy Co-operative
RFP	Requests for Proposals
RGI	Rent geared to Income

ROI	Return on Investment
RPP	Regulated Price Plan
SHP	Social Housing Provider
SNAP	Sustainable Neighbourhood Action Plan
TOU	Time-of-Use
TPO	Third Party Ownership
TRCA	Toronto Region Conservation Authority
TSI	Temporal Split Incentive
USI	Usage-related split incentives
VNM	Virtual Net-Metering
VPP	Virtual Power Plants

Executive Summary

Over the past decade, a growing number of cities, townships and regional municipalities across Canada have engaged in developing a Community Energy Plan (CEP) or a Municipal Energy Plan (MEP). Together, they have created a strong network of working groups to share resources, promote success stories, develop a working database of case studies and to generally advance the energy literacy within their individual organizations.

By developing a CEP, a municipality can influence the way energy is managed and develop priorities around energy. The primary benefits that accrue from a CEP have been documented as:

- Economic Benefits- including reduced energy spending, quality local jobs, keeping energy spending within the local community;
- Environmental Benefits – reduced GHG, healthy ecosystems, better land use;
- Health Benefits – improved air & water quality, reduction in sedentary lifestyle diseases, improved mental health
- Community Resiliency – including protection from supply and price volatility.

While there is clear and growing uptake by communities large and small in developing these plans, there is an equally clear set of challenges in moving from planning to actual implementation. The most common barriers cited are:

- Lack of relevant technical resources on staff;
- Effective public engagement processes;
- Access to project financing.

The Federal Infrastructure program recognized these same challenges and seeks to build capacity at the Municipal level to address those issues. Through programs offered by the Federation of Canadian Municipalities (FCM), they want to ensure that ‘green’ projects are financially supported by and will benefit the communities where they are located.

Since 2009, Renewable Energy Co-operatives (RECs) in Ontario have demonstrated the ability to mobilize community support and to raise community capital to finance their community-scale projects. They have recruited the relevant technical, financial and project management skills to build and operate wind, solar and biogas projects in their communities. They have been successful at identifying projects and rallying community support. And they have raised over $160M from local citizens to own those projects.

With the ending of the FIT program in December 2017, these volunteer-led organizations are pro-actively seeking new opportunities to advance the adoption of renewables into their communities. This report lays out a set of potential roadmaps for RECs to build out a vibrant, viable partnership model that can adapt as the policy landscape evolves – and can perhaps help to expedite that evolution.

Ironically, the first commercial Wind Turbine project in Ontario was jointly built in 2002 by Toronto Hydro and Windshare Co-operative. The turbine is jointly owned 50/50 by the local distribution company (LDC) and the community investors. This is a promising model that might be replicated across the province, as the majority of LDCs are owned by their local Municipality. The RECs are in a strong position to play an enabling facilitator role, building upon their community focus and capacity to mobilize community support.

Through the work undertaken for this project, we uncovered a wide range of interesting renewable energy projects, diverse community interests and creative business models. Both the RECs and the Municipalities involved expressed strong interest in exploring the potential for partnerships to accelerate projects that might otherwise sit on the shelf.

Through surveys, interviews and case studies, there emerged 2 areas of common interest-

- Energy Efficiency Retrofits
- Solar plus Storage at Community scale

These 2 models were researched in detail to identify current constraints, uncover barriers and outline potential regulatory changes that could unleash the longer-term potential.

The study participants proposed enhancements to overcome four regulatory barriers:

- Rules restricting business activities of Renewable Energy Co-operatives;
- Rules restricting 'Green Procurement' by Municipalities;
- Rules restricting 'Ownership of Distributed Energy Resources' by LDCs;
- Delayed rules governing 'Third-party Ownership' and 'Virtual Net-Metering'.

The specific roadmaps are documented in 2 companion Spotlight reports, released at the same time as this report. They are available for free download at www.trec.on.ca as part of a toolkit of resources for proponents of community-owned renewable energy.

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1. Introduction to the Education & Capacity Building (ECB) Project

This IESO-funded ECB project was jointly proposed by **Toronto Renewable Energy Co-operative (TREC)** and **Clean Air Partnership (CAP**). The project intends to build internal capacity, facilitate new partnerships and break down current barriers to collaboration between Renewable Energy Co-operatives (RECs) and Municipalities.

Consideration of community energy plans within the municipal sector is a new and emerging area for many municipalities. Their involvement in energy planning and implementation had been fairly limited, until quite recently. However, as the renewable energy markets and technologies have evolved, the capital costs of renewables have plummeted, making it even more urgent to understand the changing landscape.

The Gap for Municipalities - While a small number of municipalities have become engaged in identifying and developing community energy projects, the majority of municipalities have not. They do not have the technical expertise nor the first-hand experience to fully enable them to act on local energy opportunities. In particular, medium and smaller municipalities are at a significant disadvantage in participating in community energy opportunities despite the significant benefits it may provide them.

Based on CAP's work in advancing energy literacy, technical capacity, project planning and implementation within the municipal sector, two key challenges have repeatedly been raised by municipalities: effective stakeholder engagement and access to project financing. It is believed that RECs can and should be able to fulfill both those needs.

The Gap for RE Co-ops - Under the Feed-In Tariff (FIT) program, the IESO was the purchaser of energy generated by RECs under the 20-year FIT contract. This provided long-term revenue stability and the IESO is a low risk counterparty. In a Post-FIT world, there is a need for RECs to develop an equivalent long-term contractual agreement with a similar low-risk entity. This is a significant hurdle to overcome as payback periods for current REC projects in Ontario are generally greater than 7-10 years.

Based on TREC's work with the Federation of Community Power Co-operatives, we found that every $1 spent on Community-owned renewable energy projects results in more than $2 in further economic activity. Further, we found that community-owned renewable energy projects generate twice as many jobs as corporate-owned energy projects. And those dollars stay in the local community. It is believed that Municipalities (or LDCs that they own) should be able to fulfill that desirable counterparty role.

The Opportunity – Matching gaps with assets - The key to each economic stimulus program (whether Federal or Provincial) has been 'shovel-ready' projects that are sponsored and/or endorsed by local Municipal Councils. Community Energy projects are different – they are not familiar and well understood projects like roads, bridges, sewers and water treatment facilities. There is a clear need for capacity building at the local level – and we believe there is an opportunity for RE Co-ops to assist by filling the gap.

There is also a gap at present in the understanding among municipalities as to how RECs function. They are largely unaware of the leadership role that RECs can and do play in engaging the wider community. promoting and advancing energy literacy amongst their constituents. It is only becoming evident that RECs are an attractive and substantive financing source for the implementation of community energy projects.

The Joint Proponents believe fostering partnerships between Municipalities and RECs that harness each sector's strengths is the best way to achieve this. This will also build sustainable knowledge-sharing systems, capacity and skills in the sector to deal with present day challenges as well as issues that develop in future. By sharing resources, documenting lessons learned and promoting opportunities, these partnerships can be replicated across the province, and across Canada.

This project seeks to identify the economic and regulatory barriers faced by both RECs and Municipalities, viewed through a set of practical near-term business cases.

The ECB project was defined to consist of three (3) phases over an 18-month period. The first 2 phases were to be covered by the proposed budget –

Phase 1: Develop new Economic Models - Through initial discussions and FCPC member working groups, TREC identified 12 potential business opportunities for RECs. This study proposed to focus on three (3) opportunities that appear to have greatest potential:

a) "Community Scale Solar" – projects in the 500kW to 5MW range, modelled after a proven US example.
b) "Community Scale Virtual Power Plant" – expanding upon an existing Alectra pilot project in Markham-Vaughan.
c) "Energy Efficiency Retrofits" – accelerating the deployment of a (non-debt) financing tool developed by the Toronto Atmospheric Fund / Efficiency Capital.

Phase 2: Develop Municipality-REC Partnerships - Each of the new business models defined above will benefit from strong partnerships between a REC and a Municipality and/or Local Distribution Company (LDC). We expect RECs can play an important role in strengthening the expertise base, proving there is strong public support, and providing community-based financing for attractive projects.

Phase 3: Initiate Project Development - Phase 3 will take place outside of the ECB work plan. However, we included a brief outline of future potential projects in this report to guide advocacy work to pursue regulatory changes.

1. Extend the framework for potentially scalable projects.
2. Identify which projects can be developed right away to create "buzz" and garner local community support.
3. Recognize willing hosts – which municipalities are most interested in pursuing projects, working with RECs and
4. Identify funding sources, including infrastructure funds, etc.

By implementing innovative partnerships, new business models and proven financing models, we will empower and equip communities to forge their own energy futures.

With the right model, we can unlock vast reserves of Community Capital and mobilize Community Support. While we know there will be many challenges along the way, this initiative will help to identify workable solutions to pave a clear path forward.

2. Research Design and Methodology

The primary objective for this project is to build capacity, facilitate new partnerships and break down barriers to collaboration between RE Co-ops and Municipalities. The desired outcome will be a ‘standardized’ partnership model designed to fast-track innovative green energy projects and opening new possibilities for a “post-FIT world”. We are interested in bringing together the strengths and unique expertise of these two sectors to forge new opportunities together.

Given the broad and diverse range of potential applications for Renewable Energy, the research phase for this project was divided into 3 sets of activities – with the objective of finding a small set of common interests between the Municipalities and the RECs that engaged in the initial surveys.

A. Literature Review
B. Review of Municipal CEPs
C. REC and Municipal Webinars with Polling

This initial phase was completed in July 2018. A set of 6 potential applications was tabled for further analysis; there was high interest expressed in the top 3 models.

The second phase of the project focused on identifying the barriers to implementation that prevent Ontario communities from replicating successful projects found in other jurisdictions. This involved 3 sets of activities –

A. Interviews with Municipal staff
B. Interviews with proponents in other jurisdictions
C. Interviews with industry leaders in Ontario

The most common barriers to implementation cited by every interviewee were either economic or regulatory hurdles. The regulatory landscape changes very slowly; the cost of renewables is dropping every year, if not every quarter. The TREC team made several adjustments to the final deliverables of the project to align to the current environment.

The final phase of the project seeks to condense the learnings into 2 economic models that can be put into action, immediately. Both models can deliver solid value today, and set the foundation for success in the medium term as regulations evolve and mature.

3. Finding Common Ground

The research phase kicked off with a joint review of potential topics/applications by TREC and CAP staff. We had the benefit of some earlier focus group work within the Federation of Community Power Co-operatives and within the CAP member forums. 12 'areas of interest' surfaced along with a number of success stories from other jurisdictions.

The formal Literature Review focused on 6 topic areas, each documented in detail in Appendix A-F. Interesting case studies and phone interviews were collected spanning Ontario, Europe and USA examples. In parallel, on CAP's advice, we conducted a review of 22 Municipal/Community Energy Plans. We were looking for evidence of investment activity or actual project implementation rather than simple expressions of interest. The high-level table is shown below. Demand Response and Energy Storage scored poorly.

Sustainable Energy Type	Ajax CDM	Burlington CEP	Chatham Kent CEP	Guelph CEP	East Gwillimbury CEP	Halton Region CEP	Hamilton Climate Change Plan	Kingston Climate Action Plan	London Energy Management Plan	Markham Energy Management Plan	Niagara Region CDM	New Market CEP	Oakville CDM Plan	Ottawa Energy Transition Strategy	Oxford County 100% RE Plan	Peterborough Sustainability Plan	Stratford CEP	Vaughan MEP	Wawa CEP	Waterloo Community investment Strategy	Woodstock CEP	Windsor CEP
District Energy	Low	High	Low	Medium	High	High	Medium	Medium	High	High	Low	High	Medium	High	Low	Low	Low	Medium	Low	High	Medium	High
Demand Response	Low	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Energy Efficiency	Medium	High	High	High	Medium	High	High	High	Medium	High	High	High	High	Medium	High	High	High	High	High	High	High	High
Energy Storage	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Low	Low	Medium	Low	Medium	Low	Low
Community Scale Solar	Low	Low	Low	High	High	Medium	Medium	Medium	Low	Medium	Medium	High	High	High	High	Medium	Low	Low	High	High	High	Medium
Sustainable Transportation	High	Medium	Medium	Low	Low	Medium	High	Medium	Medium	Low	Low	Medium	Medium	High	High	Low	High	Medium	Medium	High	High	High

6 Case Studies - Webinar #1 – Municipalities

On June 15, 2018 TREC/CAP conducted a joint webinar with 23 members of Municipal governments and Provincial agencies, roughly 50/50. We shared both this table and the 6 selected case studies shown below. After each, a poll was taken asking about their current level of interest within their organization.

The table below shows the range of responses – 5 is "high"; 1 is "low". The weighted average showed Energy Efficiency, Sustainable Transportation and Solar/Storage as highest interest.

District Energy	Demand Response	Energy Storage	Energy Efficiency	Community Solar	Sustainable Transportation
4	-	5	-	4	5
3	-	-	5	-	4
4	-	4	-	-	-
4	-	5	-	5	-
5	-	3	5	3	-
3	2	3	4	5	4
2	4	3	5	3	5
5	-	5	5	3	5
4	-	4	5	5	5
3	-	-	-	3	4
5	4	-	5	5	5
-	5	-	-	-	-
5	2	-	-	-	-
-	-	-	5	-	-
4	-	5	2	4	-

Table 2: Municipal Poll Results

6 Case Studies - Webinar #2 – RECs

On July 26, 2018 TREC/CAP conducted a joint webinar with 14 members of active RECs in Ontario. We presented the same table of Municipal results and shared the same 6 selected case studies shown below. After each, a poll was taken asking about their current level of interest within their organization.

The table below shows the range of responses – 5 is “high”; 1 is “low”. The weighted average showed Energy Efficiency, Demand Response and Solar/Storage as highest interest.

District Energy	Demand Response	Energy Storage	Energy Efficiency	Community Solar	Sustainable Transportation
3	2	4	3	5	3
2	5	4	5	5	4
3	5	2	4	5	4
1	5	5	5	5	3
5	5	5		5	5

Table 3: REC Poll Results

The follow-up interviews showed a clear distinction between Municipalities and RECs on their familiarity/lack of familiarity with Demand Response and District Energy. The level of knowledge on these 2 topics trails the other 4 by a wide margin.

Case Study #1: Regent Park District Energy System:

Details on System/ Scale:

- provides heating and cooling to more than 800 residential units (using large quantities of water), commercial retail spaces, and City of Toronto Buildings.
- Community type: Mixed. Contains Retail, commercial, institutional and residential units.
- The system saves more than 400,000 tonnes of GHG emissions over 30 years.

Purpose:

- District Energy is a key component of TransformTO, Toronto's climate action plan. Its goal is to reduce emissions from buildings and reach the City's GHG reduction target of 80% by 2050.

Ownership Model:

- Toronto Community Housing runs the Regent Park Community Energy System as a joint venture, in partnership with Corix Utilities, a leading energy industry expert. Toronto Community Housing retains control through 60% ownership.

Costs and Financing:

- 90% of the funding for the project will come from reinvested operating savings, reallocation of the Toronto Community Housing capital repair funds to new construction, funds from the sale or lease of surplus land, a Toronto Community Housing equity contribution of $30 million and long-term debt financing.
- To run the district energy system, Toronto Community Housing is investing $36 million and Corix Utilities is investing $24 million

Scaling/ Future developments:

- The system is designed to be able to seamlessly incorporate power from renewable sources such solar or geothermal power. It can also be expanded to connect to future developments outside Regent Park.

Barriers to developing/expanding DE systems:

- Lack of coherent & concerted policy framework, and legislative restrictions.

- Incentive programs target individual small-scale systems - not large scaled ones.
- DE systems have high upfront capital costs with longer payback periods compared to conventional in-building systems.[1]
- It is difficult to convince building owners and operators to connect to a DE system once investments in in-building systems have already been made.
- Due to historically low fossil fuel energy prices in North America (e.g., natural gas), DE systems are not yet common in residential and commercial markets.
- Though the technologies used in DE systems are well understood, their implementation requires dedicated planning and infrastructure coordination to ensure optimal system designs and economic viability.[2]

Opportunities and Benefits of DE systems:

- DE systems can provide long-term, financially viable energy services in areas with moderate to high energy use intensities (energy use per square area of land)
- Most DE systems have the capacity to be expanded, allowing for the most economically feasible locations to be developed first, followed by the addition of commercial buildings, new developments and lower energy intensity areas.
- The most opportune time to build or expand DE systems is when new buildings or developments are being planned and built or when an existing facility is replacing end-of-life heating and cooling equipment.
- Modern DE systems that supply medium-temperature hot water (70°C to 90°C) or low-temperature hot water (less than 55°C) can improve system efficiency while also enabling the integration of renewable energy sources and a broader range of building connections.
- Centralizing the production of heating and cooling energy in this way offers several advantages compared to the decentralized model of producing heat separately in each individual home, office or building. In addition to their economies of scale and potential efficiencies, for example, DE systems can integrate multiple energy supplies, including a variety of renewable energy and waste heat sources as well as traditional fossil fuels.

[1] City of Ottawa. (2017). "Energy Revolution: Ottawa's Community Energy Transition Strategy - Phase 1."
[2] City of Ottawa. (2017). "Energy Revolution: Ottawa's Community Energy Transition Strategy - Phase 1."

Case Study #2: POWER.HOUSE Demand Response:

Details on project/ Scale:

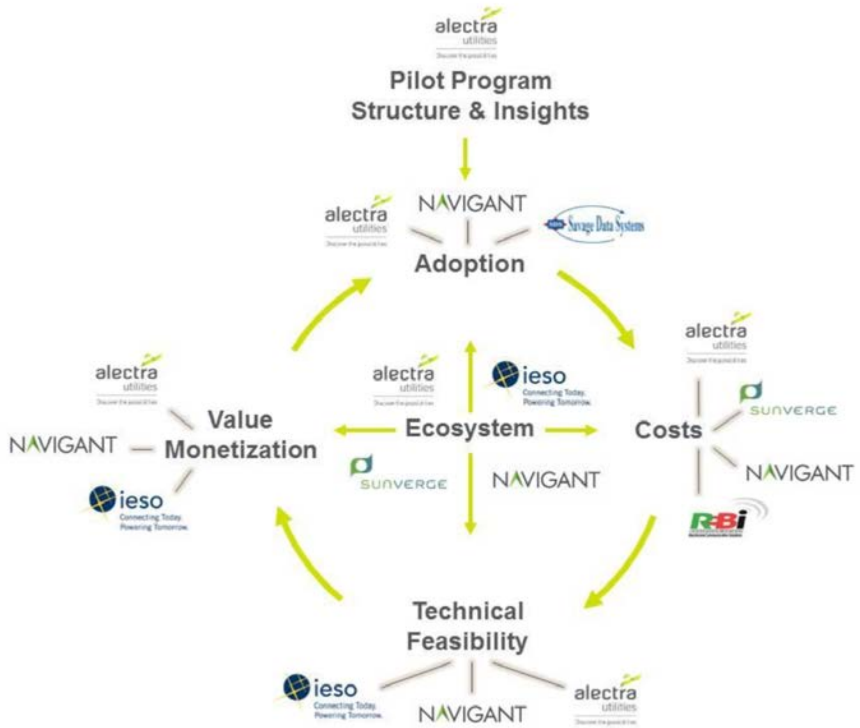
- In 2015, Alectra Utilities launched a residential solar storage pilot program, funded by the IESO Conservation Fund.
- To evaluate the benefits that aggregated residential solar storage can bring.
- The pilot program enabled the deployment of 20 residential solar storage systems in homes within Alectra Utilities' service territory.
- The pilot enables participating customers to displace a significant portion of the electricity they source from the grid and better manage the electricity that they do use, resulting in reduced energy costs, lowered carbon footprint and improved efficiency.
- Results demonstrate the technical and commercial potential that residential solar storage can achieve.
- The system is also used by the utility to contribute to grid reliability and resiliency.

Purpose:

- The POWER.HOUSE pilot was designed to evaluate the economic and grid benefits that aggregated residential solar storage can contribute
- The feasibility study was intended to primarily answer two questions:
    - Is it feasible to expand the program to a larger number of homes?
    - What are the costs and benefits of, and barriers to an expanded program
- The feasibility study conducted analyses to better understand:
    a. The potential adoption of the POWER.HOUSE technology within York Region from 2016 to 2031;
    b. the potential value streams that could be realized through increased adoption of POWER.HOUSE;
    c. the scalability and costs associated with increased adoption;
    d. the technical capabilities of the technology;
    e. the feasibility to defer or eliminate the need for transmission or distribution infrastructure upgrades to meet future demand growth;
    f. the monetary value associated with the services the technology can provide; and
    g. barriers and catalysts to widespread adoption.

Ownership model/ Governance structure:

- The partners and supporting entities that took part in the study work streams are described in the Figure below which illustrates the feasibility study structure and the entities involved:



- IESO planning staff were also involved to help frame the mechanisms for assessing the value of the program to the electricity grid, as well as to validate assumptions, approaches, and results.
- IESO and Alectra Utilities planning staff also worked together to estimate the value of deferring transmission and distribution investments, as well as the technical requirements and operability the program would need in order to successfully defer upgrading the infrastructure.
- The feasibility study team's collaboration, organization and engagement enabled the study to be successfully completed by leveraging the expertise of all entities involved.

Costs and Financing:

Table 1. Feasibility Study Archetype Program Offer

Single family home:

- » $4,500 per unit up-front
- » $80/month for 10 years
- » Payback between 4 and 5 years

Semi-detached/row home:

- » $3,400 per unit up-front
- » $55/month for 10 years
- » Payback between 5 and 6 years

Scaling/Future developments:

- In testing the technical capabilities of the pilot, it was found that in order to provide reliable demand response grid services, a POWER.HOUSE unit is required to commit in advance and respond to an event for a 4-hour duration during the afternoon.
- The results make a strong case for further study of the technical and commercial potential that residential solar storage can achieve when managed through a software control platform with advanced aggregation capabilities.

<u>Case Study #3: Firestone Community Battery:</u>

Details on project / scale:

- United Power Cooperative and SoCore Energy announced plans to build the largest energy storage facility in Colorado.
- The 4 MW, 16 MWh battery storage system will store energy generated over night and discharge it during the day to reduce demand charges.
- The system is part of its “community battery” strategy that allows co-op members to share the system’s output to reduce demand charges on their monthly electric bills. Like a community solar program, customers subscribe to the program. But instead of getting a credit for power generated, they get a credit to offset their peak demand.
- Like a community solar program, customers subscribe to the program. But instead of getting a credit for power generated, they get a credit to offset their peak demand. The program is open to anyone, but it mostly aimed at commercial and industrial customers.
- United Power does not have its own generation, it buys power wholesale from Tri-State Generation and Transmission Association.

Project timeline:

- Construction on the system is expected to begin in the first half of 2018.

Purpose:

- United Power adapted the community solar concept to the demand side of the equation with its community battery program.

Ownership model:

- A not-for-profit electric cooperative, owned by the customer-members who receive electricity from them.

- They are governed by a member-elected board of directors, who direct the operations of the cooperative, oversee needed rate changes, and help the staff and employees plan for the future of the company.[3]

Costs and Financing:

- The total investment was not disclosed, - batteries cost about $2,000/kW and United Power has already committed “millions” to the project.
- United Power estimates a C&I customer could pay back their subscription investment in about 10 years.
- Even if no customers sign up for the program, the batteries would cut United Powers peak demand and repay the investment in seven or eight years with a 10% return.
- “*The magic here is that it would take a lot of money for a C&I customer to reduce their peak demand, but it is a lot easier for the utility to manage its load profile*,” - Jerry Marizza, United Power project manager.

Scaling/Future developments:

- Successful results of the project will lead to more projects in the near future.
- Eventually, longer duration batteries will be needed to get peak demand savings and those more expensive batteries would change the economics of the project.

[3] United Power. (2015).

Case Study #4: Pajopower Streetlight Retrofits:

Details on project / scale:

- Pajo-power - A renewable energy sources cooperative (REScoop) based in Flanders, Belgium.[4] The co-op invests in renewable energy and energy efficiency
- The cooperative provides consultancy services by means of an independent energy expert who conducts energy audits upon request. The audit report prioritises the measures that are needed to improve the energy efficiency of the house. Measures typically include rooftop insulation, double glazing, heat pumps, pellets, solar PV, etc.
- LED Street Lighting retrofits - In a municipality South of Brussels, Pajopower replaced public street lights with more efficient LEDs in a community south of Brussels, Belgium (using Third Party Financing model).
- Retrofitting public buildings: In collaboration with CORE, EnergieID, Efika and MOS Vlaams-Brabant, Pajopower is also taking action to improve the energy efficiency of public buildings, like local schools. The cooperative uses the Third Party Financing model in this case.

Purpose:

- Pajo-power reaches out for both local citizens and local municipalities and helps them to improve the energy efficiency of their houses and buildings.

Ownership model/ governance structure:

- In collaboration with its founder, the NGO "Kyoto in het Pajottenland", Pajopower sensitizes local citizens for a more rational use of energy in their private houses.

EE measures in public buildings

- In collaboration with CORE, EnergieID, Efika and MOS Vlaams-Brabant, Pajopower is also taking action to improve the energy efficiency of public buildings, like local schools.
- The cooperative uses the Third Party Financing model in this case. The cooperative issues shares and uses these funds to finance the EE measures.

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[4] CITYNVEST. (2018). "Cooperative case study: Pajopower".

Financing:

- The cooperative used the Third Party Financing (TPF) model to raise funds for project
- For private citizens they have set up a EE facilitation service, for public buildings they use third party financing.
- All citizens are eligible to join the cooperative: after purchasing a share they become a co-owner of the project and share in the profits.

For energy efficiency services:

- The energy experts calculate the investment that is needed, as well as the foreseen savings. This allows the expert to calculate the payback time for the initial investment.
- The expert also helps the citizens to find good contractors and leads them to potential subsidies for their investment.
- The expert finally monitors the construction works.
- Note that it's the citizens themselves who finance the investment, the facilitation service is subsidised.

Scaling/Future developments:

- A similar EE facilitation service for private citizens will soon be replicated and upsized by Ecopower (Belgium) thanks to the REScoop MECISE project.
- REScoop MECISE project - a European project that aims to mobilize municipalities and citizens in the transition to a more sustainable and decentralised energy system. With support from EASME, a consortium of established energy cooperatives develops projects for renewable energy and energy efficiency. In addition, they seek opportunities to set-up a financial facilitation service for all European energy cooperatives.

Case Study # 5: Nelson Community Solar Garden

Details on project / scale:

- Bullfrog Power and the City of Nelson announced the launch of the 60 kW Nelson Community Solar Garden Project.[5]
- The system feeds into the grid owned by city's electric utility, Nelson Hydro. The 60 kW solar array was projected to generate 70-75,000 kWh/year, which can power approximately 7 households in Nelson.
- By January 2018, the system produced over half of the initial annual estimate, which was 36,000 kWhs.

Purpose:

- It is Canada's first community solar garden installation that is using "virtual net-metering" to showcase the future of how Canadians can support renewable energy projects in their community.

Ownership model/ governance structure:

- There was also a collective commitment by individual investors and groups from the Nelson community to support clean energy in British Columbia.

Costs and Financing:

- Bullfrog Power provided a pre-feasibility grant to the project and followed up with additional financial support during the construction phase (provided $35,000 in grants).[6]
- The City of Nelson also provided funding for the project.

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[5] Bullfrog Power. (2017). "Nelson, BC, turns on Canada's first community solar garden project".

[6] Forman, G. (2017). "Nelson, B.C. saves money with Canada's first community solar garden". David Suzuki Foundation.

- Subscribers to the Nelson project purchased their solar panels at an upfront cost of $945, with no further payments required.
- Participants also have the option of paying for every kilowatt-hour of power their panels produce over the solar garden's lifespan.
- As the panels generate electricity each month, customers receive "solar credits" that are deducted from their electricity bill. The solar credits are calculated annually and are proportionate to their share of the solar garden's production. Over time, all of the subscribers will recoup their initial investment and continue saving money on their electricity bills as long as it produces renewable energy.

<u>Scaling/Future developments:</u>

- The project is relatively small in scale and is intended to test the model for future expansion.

<u>Community involvement:</u>

- The panels were purchased by enthusiastic members which included local churches, homeowners, renters, and co-ops.
- The municipality hopes that cities across Canada will embrace the solar garden concept. Other provinces could replicate this model one day - Ontario, for example, does not yet allow virtual net metering:
- "*Nelson is providing a model for how other jurisdictions can adopt virtual net metering, which is already working in several U.S. states*," he argues. "*I hope more solar projects get built in Canada by learning from Nelson and using virtual net metering to get communities involved in how their energy is generated.*" - Dave Borins of Bullfrog Power

<u>Case Study #6: Minnesota Electric School Bus:</u>

Details on project / scale:

- In Minnesota, two power co-ops partnered with a school bus manufacturer in Canada to send children to school in an electric bus, one of less than 100 currently operating in North America.[7]
- The eLion bus, manufactured in Quebec by Lion Electric Co., is powered 100% by electricity, seats 72 passengers and has a range of 100 miles per charge. With the average school bus route being around 66 miles according to the National Rural Electric Cooperative Association, this means that these electric buses should have more than enough range to provide service.[8]

Purpose:

- The project aims to test electric school bus performance in cold weather climates and on longer suburban and rural routes.

Ownership model/ Governance structure:

- Great River Energy is a power cooperative and the organization's members and owners are 28 Minnesota electric distribution cooperatives. Individuals and businesses are members of those distribution cooperatives based on their geographic location. Great River Energy is part of a nationwide alliance made of more than 750 electric cooperatives in 46 states

Costs and Financing:

- The cost of the bus was shared equally between Great River Energy, the electric co-op Dakota Electric Association, and Schmitty and Sons Bus Co.[9]
- According to Midwest Energy News, The buses will cost $325,000. This is three times the cost of conventional diesel-based school buses.
- However, it costs around $12,000 annually (approximately $1000 per month) to operate.[10] The average vehicle maintenance and repair cost for conventional school buses is around $14,000 ($1170 per month).[11] This translates to cost savings of about $170 per month, or around $2,000 annually.

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[7] Walton R. (2017). "Minnesota co-ops launch electric school bus pilot".

[8] Walton R. (2017). "Minnesota co-ops launch electric school bus pilot".

[9] Walton R. (2017). "Minnesota co-ops launch electric school bus pilot".

[10] Jossi, F. (2017). "Minnesota district to get Midwest's first electric school bus this fall". MidwestEnergyNews.

[11] Bus Maintenance Cost Template MSBO. (2011). Bus Leasing Cost.

Funding programs:

- Clean energy groups throughout the U.S Midwest, along with several utilities have been advocating the use of Volkswagen settlement funds for electric school buses. The settlement agreement will bring $47 million to Minnesota over the next 10 years and a portion of that funding could be used to add more electric school buses.

Benefits of Electric buses:

- Maintenance and variable costs of electric buses have been proven to be lower than diesel alternatives, along with an improved energy efficiency.[12]
- The projected falling costs of lithium batteries will further reduce costs in the near future.
- There is also the added benefit of improved safety and comfort in the form of better ergonomics and a composite roof to mitigate rusting and leakages.
- There are no carbon emissions since the bus company is a part of Great River Energy's Revolt EV Program, which charges electric vehicles entirely by wind energy.[13] The bus will also be charged overnight when electric rates are lower in order to further reduce costs.
- GHG emissions saved = Diesel buses annually emit 95,000 tons of GHGs[14.]

Scaling/Future developments:

- The settlement agreement will bring $47 million to Minnesota over the next 10 years and a portion of that funding could be used to add more electric school buses.

- Cooperatives serve more than 8,000 of the United States' 13,325 school districts, which means that partnerships like Great River and Dakota Electric's could provide a feasible model for scaling the project.[15]

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12 Adheesh, S. Shravanth, V. Ramasesha S. (2016). "Air-pollution and economics: diesel bus versus electric bus". Divecha Centre for Climate Change, Indian Institute of Science.

13 Jossi, F. (2017). "Minnesota district to get Midwest's first electric school bus this fall". MidwestEnergyNews.

14 CleanAir Trust. (2017). School bus pollution. Retrieved from: http://www.cleanairtrust.org/buses.html

15 Jossi, F. (2017). "Minnesota district to get Midwest's first electric school bus this fall". MidwestEnergyNews.

One-to-one Interviews

Following the webinars, a set of interviews with Municipal staff were conducted to understand what types of concerns, issues or obstacles might be encountered. The following Municipalities were willing to provide their insights:

- City of Guelph
- City of London
- Region of Waterloo
- City of Mississauga
- City of Ottawa
- City of Vaughan
- City of Richmond Hill

The interviewees expressed a range of thoughtful questions and concerns. The common themes are shown here in Table 5.

Governance	• What are the exact benefits of partnering with a co-op? • To what extent will member decisions influence the outcome of the project? • How will the ownership model work for the project? • Will ownership be exclusive to members? • If it is a partnership model (public/municipal/private/co-op) what issues would need to be factored into that model?
Regulations	• Are there constraints for developing a project where a renewable energy co-op will lead the project? • What kind of co-op regulatory changes are required for some of those projects to be feasible?
Risks & mitigation	• Any co-ops that have experience delivering these services? • What would be the project risks that would be of most concern to co-op members? • who will take on the responsibility of risk and liabilities/ insurance?
Community Engagement	• To what extent will citizens/residents be involved in the development of the project (focus area)? • What role does the investors play in project development? • How can their investment can be used to leverage support for community energy and other climate change actions?
Financing	• Can the funding raised through community investment alone suffice to finance the full project? • What types of community financing models will be used? Will it create any limitations on the project? • What types of sureties are they likely to need in order to invest?

4. Solving Implementation Challenges in Ontario

When considering new business models, the tendency is to jump right to the economic model to judge the viability and investment-readiness of the opportunity. However, during interviews it became apparent that it is the regulatory environment that dictates the 'legality', and therefore the scope and the viability of the business model. Given the slowly evolving nature of the regulatory oversights, this demands that every proponent of any new venture must consider first what is allowable in the short-term vs the medium-term; and then consider the economic model.

The top-cited challenges heard form interviewees are listed in Table 4, below.

Sustainable Energy Type	Challenges and Issues
District Energy	Lack of coherent & concerted policy framework. Incentive programs target individual small-scale systems - makes it difficult to scale up/ implement community-scaled systems. Overlap in legislation - results in complicated approval processes (zoning/permitting).
Demand Response Programs	'Behind-the-meter' – under regulatory review - prevents utilities and RECs to develop aggregation business models for consumers in Ontario.
Energy Efficiency	High capital costs associated with retrofitting older communities. Lack of trained workforce. Split incentive that pits owners against tenants (who actually pays vs who benefits from energy retrofit investments).
Energy Storage	'Behind-the-meter'- under regulatory review – single-site economic limitation for co-ops under current regulations.
Community Scale Solar	Uncertain timeline for regulatory changes around net-metering - third party ownership and virtual net-metering, TOU rates Presence of termination clause that allows LDCs to terminate contract.

	Consumer misinformation around what the new net metering policy & conditions will be.
Sustainable Transportation	Fleet electrification is expensive. Lack of EV infrastructure and range anxiety. Difficulties implementing charging stations due to zoning regulations, permitting, and complicated approval process.

Table 4 – commonly cited challenges

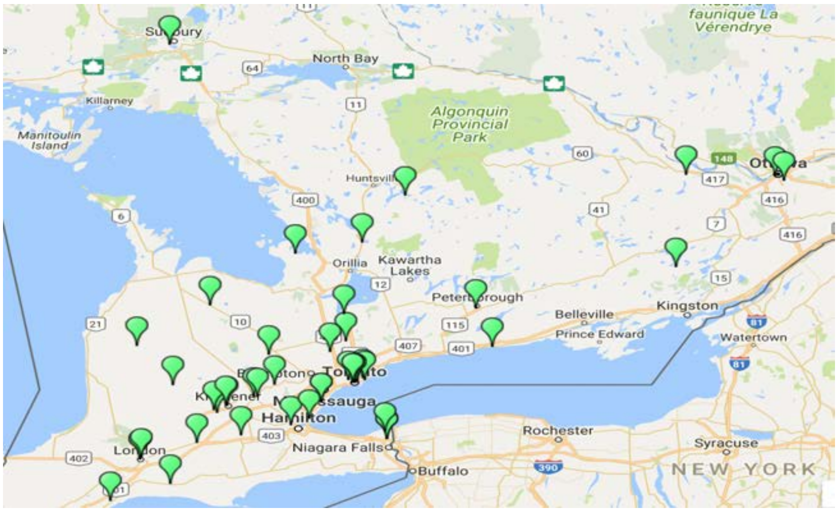
Removing rules restricting business activities of RECs

What is a Renewable Energy Co-operative (REC)?

A REC is defined as a co-operative business corporation owned and governed by its members, which can generate and sell renewable electricity, as well as raise financing for such projects. They own and operate their generation systems and generate a fair return for investors over time.16 RECs can be either for-profit or not-for-profit; with share capital or without; managing one project or a whole portfolio. The goals of all RECs is to meet the needs and interests of their members, facilitate the development of community power projects, and ultimately aim to put some decision-making power with respect to energy management into the hands of communities.

There are 46 active RECs in Ontario, registered through the Financial Services Commission of Ontario (FSCO). All current Ontario RECs are volunteer-led - their core strengths lie in mobilizing community support, creating private capital, and building the technical know-how and expertise to develop and operate community scale power projects. SolarShare is a great example – they own and manage a portfolio of community solar projects totaling over 18.5 MW of installed capacity valued at a total of approximately $80 million across the province. RECs have proven to be key advocates in Ontario's energy industry, and have made community and cooperative participation ownership a key practice within Ontario's energy industry.

[16] Toronto Renewable Energy Cooperative (TREC). 2016.



What are Electricity Co-operatives?

Similar to an investor-owned Power Utility or a Local Distribution Company (LDC), an Electricity Co-op provides electricity and associated services to its customers. Unlike those other entities, an Electricity Co-op is owned by its members and operated for people of the community.[17] Its goal is to provide reliable power at-cost service, and not make a profit.[18]

In the United States, there are more than 900 electric co-ops, which were established to provide electric service to 47 states across the country.[19] Serving primarily rural areas, these electric co-ops now make up the largest electric utility network in the country. Electric co-ops in the US are typically retail Distribution cooperatives or are Generation and Transmission cooperatives (G&Ts) that provide wholesale power through their own generation or by purchasing power on behalf of the distribution members.[20]

In Ontario, there is only one Electricity Co-operative, Embrun Hydro[21], which operates as a local distribution company. EH operates under the LDC restrictions set under the Electricity Act. (see below).

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[17] MJM Electric Cooperative. (2017).

[18] National Rural Electric Cooperative Association. (2018).

[19] National Rural Electric Cooperative Association. (2018).

[20] America's Electric Cooperatives. (2017). "America's Electric Cooperatives: 2017 Fact Sheet".

[21] MacArthur, J. (2016). "Empowering Electricity: Co-operatives, Sustainability, and Power Sector Reform in Canada.

Regulatory Challenges for RECs in Ontario

The Ontario Co-operative Corporations Act attempts to balance the business and social objectives of co-ops by outlining certain legal definitions and limitations in order to regulate the way in which co-ops are structured and how they operate.[22] In Ontario, all co-operatives are required to conduct at least 50% of its business operations with its members. Known as the "50% Rule", it is important to note that this regulation does not exist in other Canadian provinces and territories (with the exception of a more limited restriction in the Quebec co-op legislation).[23]

The Ontario Co-operative Association has made loud and forceful recommendations to the Ontario government to eliminate this rule. They contend that this rule is a major and restrictive barrier which handicaps co-operatives from fairly competing with other businesses. Their submissions are under review by the Ministry of Finance.

The Ontario Green Energy Act provided an exemption to RECs to allow them to sell 100% of their energy to the public grid. Along with that exemption, RECs are strictly confined to generating and selling electricity from renewable energy sources.[24] They cannot buy, store nor distribute electricity, generate nor conserve other forms of energy. These limitations inevitably pose a challenge for RECs to expand their business operations, implement community-scaled power projects or invest in energy efficiency or fuel switching projects.

When the 50% rule is lifted, RECs will be able to revert to a 'normal' co-operative structure, thus freed from the REC restrictions.

Fostering 'Green Procurement' by Municipalities

Green Procurement is defined as the purchase of goods and services that minimize environmental impact while providing the best value. All Ontario Municipalities must meet the Ontario Procurement guidelines – including open tenders for purchases over $25,000 and considering environmental factors for contracts over $10,000

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22 Shewan, I. (2012). "Canada: The 50% Rule And Ontario Co-operatives". Mondaq.

23 Shewan, I. (2012). "Canada: The 50% Rule And Ontario Co-operatives". Mondaq.

24 Financial Services Commision of Ontario. (2013). "Tips for Renewable Energy Co-operatives Relating to Articles of Incorporation and Amendment". Queen's Printer for Ontario.

The Municipal Collaboration for Sustainable Procurement (MCSP) is a member-based network of 20 Canadian municipalities, colleges, and universities, who are striving for operational excellence by collaborating and sharing resources to further sustainable (green, social, and ethical) purchasing. The MCSP is a front-runner in setting new benchmarks and best practices in the field of sustainable procurement.

Led by the cities of Ottawa, Edmonton, Saskatoon, Kelowna, Vancouver and Calgary and the University of British Columbia, the MCSP provides a forum for members to share information, resources, technical expertise in sustainable procurement and other key supply chain topics.

<u>City of Toronto - Green Market Acceleration Program (GMAP) -</u>

- Passed by Council in September 2015 as a pilot; renewed in 2018
- Council directed City Divisions to work with GMAP to assist local companies in their applied research, pilots and demonstrations needs
- Allows City Divisions to sign agreements where there is no financial transaction

Various councils have attempted to develop a standardized ‘green procurement’ policy framework –

- adding an environment clause to RFQ when purchasing over $5,000;
- requiring Energy Division consultation on RFPs over $50,000
- implementing green building standards for over 10,000 sq ft
- checklist for 3rd party ‘best practices’
- shifting to having a staff procedure everyone has to follow outside the bylaw

What are the implementation challenges?

- Currently no way to monitor/track impact of green policies
- Need to develop KPIs to make it easier to track
- Staff confusion and difficult buy in - training and education may help
- Green perceived as more expensive - education on life cycle costing will go a long way

Easing restrictions on ownership of Distributed Energy Resources by LDCs

According to the Electricity Distributors Association (EDA), the growth of DERs will require a major shift in utility business models. The most important requirement for utilities is to be able to aggressively pursue owning and operating DERs in an adaptive regulatory environment. Currently LDCs:

- Are required to file a notice to the OEB prior to constructing or purchasing a generation facility,
- Are restricted to DERs in-front of the meter which limits the services and options that LDCs may be able to provide to a customer
- Lack clarity on the point of demarcation for “ownership” and “operation” with respect to LDC ownership of DERs behind-the-meter.
- lack specific criteria to guide them in the evaluation of ‘non-wires’ solutions, including DERs

Specifically, the EDA sees the LDC of the future playing a key role in Ontario’s energy transition as a Fully Integrated Network Orchestrator (FINO). As a FINO, the LDC of the future will potentially enable, control and integrate DER within its distribution service territory. This vision is significantly different from the current LDC model in 3 key dimensions –

1) The extent to which an LDC provides a DER enabling platform
2) The degree of DER ownership by an LDC, and
3) The degree of control and operation of DER

Expediting ‘Third-party Ownership’ and ‘Virtual Net-Metering’ rules.

In September 2018, the Ontario Government revoked proposed legislative changes that would have helped grow the renewable energy sector in the province. Specifically, they withdrew two proposed regulations under the Ontario Energy Board Act, which would have allowed for third-party ownership of net-metered facilities, as well as flexibility for virtual net metering pilot projects.

The tremendous surge in Community Solar in the USA is directly attributable to rules which allow third-party ownership (TPO) and virtual net-metering (VNM) in 17 states.
For RECs in Ontario, the removal of TPO places restrictions on the type of contract that can be offered. Instead of a flexible Power Purchase Agreement, whose terms can be tailored to the project, the REC must instead use a less flexible 'Solar Equipment Lease'. Joint ownership models become more complex to administer.

The more severe restriction under net-metering today is the requirement that the solar array must be on the same site as the customer load – and the power generated must be consumed exclusively by that single customer. Virtual net-metering allows the REC owner to locate the solar generation array on the most optimum site, built to the optimum scale. The generated power is then sold to the grid and the credits are shared by multiple member-consumers within the local LDC footprint, to reduce their bills.

The current net-metering rules in Ontario do allow for energy storage, in conjunction with solar generation. There is interest in offsetting a demand customer's peak load using solar plus storage, however, the economics currently are not viable except at the scale of a Class A industrial customer. This could change dramatically once VNM is implemented, as the storage could be shared across multiple Class B customers.

5. Representative Economic Models

This section provides a profile of each of the 2 Economic models that emerged from the research. Both of these models are currently being trialled on a pilot basis in Ontario.

Spotlight: Energy Efficiency Retrofits

As Ontario's electricity grid has become relatively decarbonized over the last decade our attention has turned to the building sector, which accounts for the second highest GHG emissions behind transportation. Improving **energy efficiency** (EE) in our buildings, fuel switching and onsite renewable energy (RE) generation have been the primary methods to achieving significant reductions. While energy efficiency and GHG reduction for new builds is being addressed through increasingly stringent building code standards, it is our existing building stock in **urban and suburban settings** that is the primary challenge we must address. Built with 1960-era lower energy standards yet with 80 -100 year design lifetimes, they will continue to emit GHGs for decades to come. **Unless we act now**.

Energy Service Performance Contracting has emerged as one of the more successful solutions to removing many of these barriers. The service providers (known as ESCos) directly address the lack of capital and lack of technical expertise. In most cases, they transfer performance risk away from the building owner, which is also very attractive.

ESCos have primarily focused on the institutional market, as the scale of these projects make them more profitable. They are also attractive clients due to their tolerance for longer payback times and longer periods of stable ownership. Adoption of the ESPC model has seen limited success in the residential sector, although some companies and non-profit organizations have been able to make headway into the social housing and multi-unit residential sector in more recent years.

The commercial market offers a huge opportunity for GHG reductions – if only it wasn't so complex, so varied, so fragmented, so adverse to change. The ESCo model is totally dependent on the financial return to the building owner and yet it is their tenants who ultimately see the savings. For a large enough project, the stakeholders are motivated to work through the complexity and they always find a way to structure a winning deal.

Can we extend this successful ESCo model down-market to the small-to-mid-size commercial property? Or to smaller municipal-owned properties? **Renewable Energy Co-operatives** (RECs) can offer a potential solution to these 'lack of scale' challenges through their proven ability to mobilize local community support and their access to community financing. RECs can **change** the ownership model. RECs can **aggregate** small projects into larger portfolios. RECs can **educate** and provide technical assurance. And RECs can **partner** with their local municipality to **promote** local action plans.

The REC model of **community ownership of local community assets** places a clear focus on the local neighbourhood – creating a social bond to the initiative alongside a financial return. The commercial property owners and the building tenants ARE our neighbours.

Spotlight: Solar plus Storage

Ontarians have enjoyed the benefits of an electricity grid that is mostly clean, mostly reliable, widely accessible and relatively affordable. But the future energy consumption needs and ratepayer expectations are changing dramatically and at a frenetic pace. The clearest challenge to the current centralized-control model comes from the worldwide consumer adoption of the highly disruptive, fully-distributed 'do it yourself' electricity generation from solar panels. **80% cost reduction in 5 years gets people's attention**.

As with any large, complex system, there is an inherent inertia that does not adapt easily to change – especially disruptive change. The Ontario electricity system operator (IESO) along with the Ontario Ministry of Energy have engaged in years of consultations in public and private forums. The key policy options for the mid-term (5-7 years) are well documented but there is no clear roadmap nor timetable for introducing the required new policies and regulations. The inevitable changes <u>will</u> come; that much is certain.

Since 2009, **Renewable Energy Co-operatives** (RECs) in Ontario have demonstrated the ability to mobilize community support and to raise community capital to finance their community-scale projects. With the ending of the FIT program in December 2017, these volunteer-led organizations are pro-actively seeking new opportunities to advance the adoption of renewables into their communities. This report lays out a set of potential roadmaps for RECs to build out a vibrant, **viable business model that can adapt** as the policy landscape evolves – and can perhaps help to expedite that evolution.

The two drivers of the business models, as contemplated, are economics and regulatory environment. The **public utility model** divides the stakeholders at the meter, as defined by the regulator. All ratepayers operate behind the meter (BTM) in an unregulated environment; the IESO system operator, local utilities, bulk power suppliers and HONI transmitters operate in front of the meter under OEB regulatory oversight.

The FIT program specifically opened the door to empower community co-operatives to become suppliers to the IESO system. RECs learned, invested and developed projects across the province and are now operating them under 20-year supply contracts. The favorable economics and stable long-term contracts built a thriving business model. This central procurement model for renewables is unlikely to be repeated in the future.

In 2019, the only opportunity for RECs is to be a supplier to the ratepayer, **operating behind the meter**. The rules that govern this situation fall under Net-metering (NM), discussed more fully in chapter 1. The current solar economics do make this model viable, for projects of a certain scale, if the ratepayer is a long-term stable entity. This represents an exciting opportunity for RECs, by working with local Municipalities and local LDC utilities, to build on their past successes to accelerate their community's adoption of solar. **Local examples of success are contagious**, when promoted properly.

The amended Net-metering rules introduced in 2018 permit the inclusion of energy storage in projects. However, at present there is no viable business case for storage under current Ontario rates, except for very large Class A customers. Rapidly dropping storage costs (76% since 2012[25]) will eventually change that picture but likely outside of the 5-7 year window. We include several **interesting storage examples from other jurisdictions** which are examined in Chapter 3.

The REC community has long advocated for Ontario to adopt the **Virtual Net-metering (VNM) rules** that have created a tsunami of community-owned 'Solar Gardens' across 17 US states. The Ministry of Energy came close to introducing these rules in 2016 but then retracted them, citing further consultation needed. If re-introduced, VNM would create a ten-fold increase in distributed solar generation within years. Chapter 3 fills in some of the details of the new business models possible under such an open framework.

Over the longer term, the greatest positive impacts will come from operating under a new model of **co-operating 'across the meter'** - between the local LDC utility and the BTM ratepayers. Instead of 'us vs them' it holds the promise of delivering economic benefits to all stakeholders. The RECs can play an enabling facilitator role, building upon their community focus and capacity to mobilize community support. As the IESO evolves the market for ancillary services, and as the LDCs themselves evolve, this could be the ultimate business model for the sector.

[25] Utility Dive. (March, 2019). Electricity costs from battery storage down 76% since 2012.

6. Key Considerations for Successful Partnership Models

1. Municipal & REC: mutual Interest

Each of the successful RECs across Ontario has learned how to tap into the expertise and skills of their membership. They draw upon willing and capable volunteers to identify promising projects, to mobilize community capital and to marshal relevant technical resources. They have proven their capabilities to develop, construct and operate successful solar projects. They know how to work cooperatively and collaboratively.

The challenges facing Municipal staff when considering any 'new' project are wide-ranging, continually changing and often unpredictable. Engaging Municipal councillors and staff is a time-intensive, lengthy and iterative process. The project has to work its way up from the basement to the top floor, garnering support and overcoming each hurdle or obstacle as they appear. Long projects will inevitably face election uncertainty.

Partnerships succeed when both partners 'look out' for their partners' interests as vigorously as they 'look out' for their own. In every case, the process begins with a compelling project idea, an inspiring story and a pair of confident public champions. Identifying the project site early on is absolutely critical to recruiting the appropriate champions – it points directly to the neighbourhood that will be impacted, positively or negatively. The 2 champions will need to rally and grow community support and council support simultaneously – and maintain that support until the project is complete.

2. Governance Structure and Ownership Model

Community ownership of community assets is a powerful idea – but in practice, project ownership can take a limited number of forms –

- Incorporated Joint Venture
- Public-Private-Partnership (PPP)
- Limited Partnership
- Owner/Contractor

The project ownership model determines who owns the assets, both during the term and at the end of the agreement, who carries the liabilities, who incurs the risks and who gains from the disposal or sale of the asset. It may also determine who finances, operates, maintains and decommissions the project, after the end of its useful life.

It is the governance model that becomes critical when the project has a multi-year lifecycle. It is unlikely that the people who initiate the project will be the same people who see the project through to the end. It is likely that the business goals and priorities of both partners will change over time. Proper definition of how the partners will govern the future management decisions, including voting mechanisms and dispute resolution, must be documented. There are a number of challenges inherent in the rules for RECs and the rules for Municipalities that have to be met by the final chosen structure.

3. Economic/Financial Viability

The financial skills and project expertise that the RECs have built during the FIT program provides a solid foundation for future partnerships. They have earned a solid reputation for developing 'investible' business plans, raising significant community capital, whether through bonds or shares, and managing those investor dollars prudently. They have a solid grasp of the fundamentals -

- Economic Modelling of Opportunities
- Scenario Analyses and Sensitivity Analyses
- Typical and Desirable Payback Thresholds
- Community Investment Options
- Federal, Provincial, and Municipal Incentive/Rebate Programs.

Raising Community Capital from investors requires the partners fully disclose the project finances, the intended (and actual) use of funds, and demonstrates clearly how the investor will be repaid their capital (and when). All investments are risky – it is essential that those risks be identified, documented and managed. In the case of a partnership, it is even more important that who owns the risks is identified, avoiding surprises later.

As part of this project, a number of interesting business models were reviewed from jurisdictions outside Ontario. In many cases, the economic viability was dependent on specific tax incentives or local rate structures. However, the continuing drop in the capital costs for wind and solar are quickly approaching the point where incentives are not needed to prove viability.

4. Project Scalability

Almost all Renewable energy projects have a ‘sweet spot’ – a scale at which the project is big enough to be economically viable, yet small enough to be managed by a community. The range of Community Solar projects in the US today spans $120,000 to $12,000,000 – and growing. This is clearly within the confidence range of community RECs in Ontario.

RECs in particular like to share knowledge and expertise with other RECs. Successful community projects inspire other communities to replicate or build upon what they have accomplished. Municipalities behave in the same way; success breeds replication and sometimes, competition. The lesson here is to ‘think big enough’ to garner community support and to galvanize the partnership team into action.

Appendix A: Community Solar Literature Review

Section 1 - Overview of Renewable Energy Planning in Ontario:

<u>Current policy environment and incentive programs for solar developments in Ontario:</u>
Ontario's Green Energy Act (GEA) was introduced in 2009 and intended to stimulate renewable energy development, boost energy conservation, and create green jobs. One of the key components of the GEA was the introduction of its Feed-in-tariff (FIT) program, which expanded the opportunities for developing renewable energy projects.[26] This incentive program sought to reward renewable energy producers through contracts with guaranteed rates on the price of electricity that was generated (through solar, wind, or hydro). In applying for contracts, feasibility studies were conducted in order to determine if there would be a reasonable rate of return on a project. The microFIT program was also implemented for small non-commercial systems, while the FIT program was ideally for larger commercial projects. These projects ranged from large-scale solar or wind farms, to small-scale systems such as a solar panel on a homeowner's roof. It is important to note that the applications for contracts were open to a diversity of stakeholders. This enabled many small-scaled projects to enter the electricity market in Ontario.

It is also important to note that the GEA established a new form of co-operative, the Renewable Energy Co-op (RE co-op). A RE Coop is defined as: "*A co-operative business or social enterprise, owned and governed by its members, which can generate and sell electricity, as well as raise financing for such projects*".[27] RE co-ops help communities that are lacking in resources by empowering them to build energy projects that are community-focused, while generating both electricity and cost-savings. The core objectives of RE co-ops are to address the needs of their members, facilitate the development of community power projects, and ultimately aim to create a more democratic and community-driven system when it comes to energy management.[28] SolarShare is a good example of a RE Coop that has coordinated and managed a portfolio of community solar projects across the province that are valued at a total of approximately $60 million.[29] RE co-ops have therefore, proven to be key players in Ontario's energy industry.

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[26] Ontario Green Energy Act, (2009). S,O. Chapter 12. Queen's Printer of Ontario.

[27] Toronto Renewable Energy Cooperative (TREC). 2016.

[28] Toronto Renewable Energy Cooperative (TREC). 2016.

[29] SolarShare. (2018).

What is community solar?

A report published by the Smart Electric Power Alliance (SEPA) defines a community solar program as: **"***A voluntary business model where multiple subscribers pay for a share of a specified offsite solar project and receive credit on their electricity bill for their portion of power produced*".[30]

Community solar programs have gained a foothold across the United States, where many of the most active states have state policies which support these programs (**Figure 1**). It is important to note that the specific language used in these policy frameworks vary with respect to the scale, bill credit rate, and the flexibility of third-party ownership.

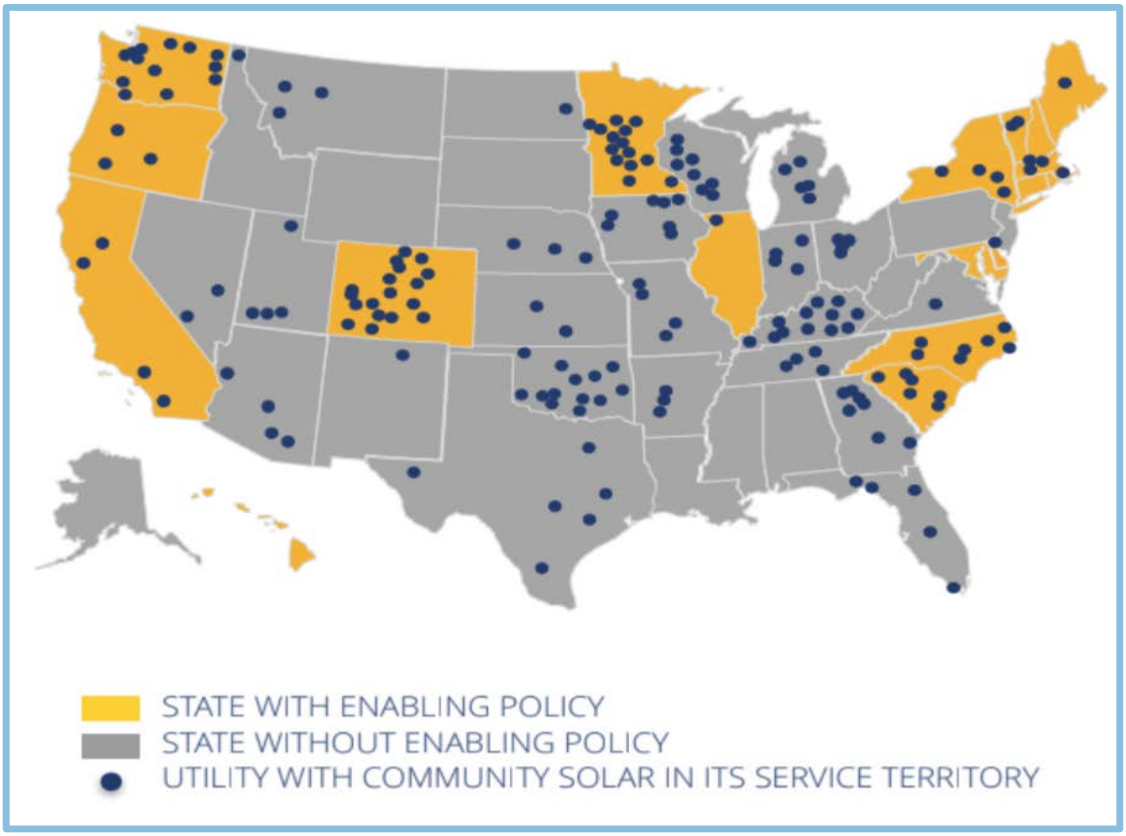

Figure 1: SEPA Community Solar Database (2018)[31]

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[30] Smart Electric Power Alliance. (2018). Retrieved from: https://sepapower.org/resource/community-solar-program-designs-2018-version/

[31] Smart Electric Power Alliance. (2018).

Challenges with developing solar projects in Ontario:

Despite the successes of the GEA, there has been much controversy with regards to its implementation process. The issue of high electricity prices for consumers in Ontario for instance, has often been blamed on the FIT program.[32] The prices that the government assigned for the contracts were arbitrary and in some instances, the prices reached 40 times the actual market value of electricity.[33] This is because the policies behind the FIT programs did not consider pricing, such as competitive bidding processes that would have lowered electricity prices. A lack of long-term foresight when formulating GEA policies ultimately led to locked-in contracts and an over-manipulation of Ontario's energy sector.[34]

Furthermore, a report from the Fraser Institute titled "*Environmental and Economic Consequences of Ontario's Green Energy Act*," stated that the GEA only generated minimal environmental benefits at a cost of approximately ten times more than alternative carbon reduction measures.[35] It is also important to mention that there are indirect costs that must be accounted for when integrating renewable energy systems into the conventional electricity grid. These costs stem from adding new generators for renewable sources and building the infrastructure to support them.

The 'Global Adjustment' is a financial mechanism that is used by the Ontario Power Authority (OPA) to cover these costs, which had the negative effect of further increasing electricity prices for Ontarians.[36] In addition, the recently announced plans to refurbish existing nuclear power stations in Ontario have compounded the issues pertaining to electricity prices, namely due to the exceedingly high costs associated with nuclear projects.[37] Although the FIT program was instrumental in establishing various renewable energy projects across the province, Ontario recently scaled back and closed FIT applications in 2017, thereby creating uncertainty with respect to the future of renewable

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[32] Corcoran, T. (2016). "Boondoggle: How Ontario's pursuit of renewable energy broke the province's electricity system". Financial Post.

[33] Hill, B. "Key project at Darlington nuclear facility hundreds of millions over budget, delayed". 2017. Global News.

[34] Hill, B. "Key project at Darlington nuclear facility hundreds of millions over budget, delayed". 2017. Global News.

[35] McKitrick, R. Adams, T. (2014). How green energy is fleecing Ontario electricity consumers". Financial Post.

[36] McKitrick, R. Adams, T. (2014). How green energy is fleecing Ontario electricity consumers". Financial Post.

[37] Hill, B. "Key project at Darlington nuclear facility hundreds of millions over budget, delayed". 2017. Global News.

energy development in the province. Furthermore, various RE co-ops and businesses that focus on renewable energy have now been left astray, threatening their survival.[38] Ontario's revised Long Term Energy Plan includes a net metering program that allows building owners greater access to renewable energy technologies and storage. However, there are various underlying conditions that limit the degree of flexibility with which RE co-ops can tap into community power projects. In addition, there are pending regulatory changes that have created uncertainty with Ontario's net metering legislation. Existing issues include restrictive clauses under current policies which stipulate that any electricity generated under the net-metering program can only be used for the generator's own use. Additionally, there is misleading information provided to customers with respect to savings, the use of credits, and the effects on rates after entering the net-metering program. There is also the presence of a termination clause outlined in net-metered contracts that allow LDCs to terminate contracts with only 30 days notice. This culmination of issues has deterred investors from considering net metered projects.

It is also worth noting that there are different categories of net metering. The most basic net-metered model is basic meter aggregation, where a solar installation can be installed on the same or adjacent property and there may be multiple meters on the same site (example - farm). Single entity net metering typically occurs where there is a solar installation on a single property behind a meter on site (example - home).[39] Conversely, multiple entity net metering is where there are multiple owners, or one owner and many renters sharing the savings generated from a solar installation (example - apartment building). Lastly, virtual net metering and/or community solar is a system where the solar installation can be located offsite and the savings can be shared amongst subscribers to the project (example - community buy-in).[40]

Section 2 - Identifying Opportunities for ECB Project:

In identifying potential opportunities for the ECB project, a review of successful cases undertaken by other co-ops, municipalities, and private developers (primarily in the United States and Europe) was conducted. This phase of the project served to examine the challenges associated with relevant projects, identify the lessons learnt, analyze the regulatory environment, highlight innovative financing mechanisms and governance

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[38] Toronto Renewable Energy Cooperative (TREC). 2016.

[39] Farrel, J. (2016). The Many Categories of Net Metering (infographic). Renewable Energy World. Retrieved from: https://www.renewableenergyworld.com/articles/ucg-content/2016/10/03/the-many-categories-of-net-metering-infographic.html

[40] Farrel, J. (2016). The Many Categories of Net Metering (infographic). Renewable Energy World.

structures, and finally evaluate the potential to replicate similar models in Ontario. It is expected that the case studies will better inform decision making and provide valuable reference material for moving forward.

In order to gauge the level of interest with respect to key focus areas, an analysis of 22 Municipal Energy Plans (Corporate Energy Plan, Community Energy Plan (CEP), Sustainability Plan, and Climate Change Plans) was conducted. The results indicate that Energy Efficiency, District Energy/ Geothermal, Renewable Energy, and Transportation Electrification are high priority carbon-reduction measures for municipalities within Ontario. For the **Renewable Energy - Community Solar** focus area, the following case studies have been selected for an in-depth review:

Case 1: Nelson, B.C - Community Solar Garden
Case 2: Community Solar Farm in New York - Net Metering

These case studies were chosen primarily due to their community focus, emphasis on active citizen participation during the development process, and the potential for renewable energy co-ops to replicate similar models in Ontario.

Case 1: Nelson, B.C - Community Solar Garden

Bullfrog Power and the City of Nelson announced the launch of the 60 kW Nelson Community Solar Garden Project in 2017.[41] It is Canada's first community solar garden installation that uses "virtual net-metering" to showcase the future of how Canadians can support renewable energy projects in their community. B.C's virtual net metering policy which allowed them to develop this project is similar to virtual net metering policies that have been implemented in other jurisdictions such as Nova Scotia, Colorado, Maryland, and Washington D.C[42]. However, it is important to note that there are issues with the current framework in B.C. Currently, the billing process is such that bills are required to be associated with a single customer, thereby requiring an overhaul for project installations where credits are to be divided amongst multiple customers to allow for virtual net metering. Currently, BC Hydro addresses this issue by suggesting that customers 'own' the net metered installation in order to carry out the administrative task of sharing energy offsets between other customers. Despite this hurdle, BC Hydro

[41] Bullfrog Power. (2017). "Nelson, BC, turns on Canada's first community solar garden project".
[42] BC Power smart. (2017). Retrieved from: https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/regulatory-planning-documents/integrated-resource-plans/current-plan/20170426-BCH-Rate-Schedule-1289-Net-Metering-Eval-RPT-4.pdf

recognizes that virtual net metering is a growing trend that has potential in island and coastal communities[43]

Bullfrog Power provided a pre-feasibility grant to the project and followed up with additional financial support during the construction phase (provided $35,000 in grants).[44] The City of Nelson provided $25,000, and the Province of British Columbia provided $20,000 in funding for the project. The rest of the funding was provided by investors, where subscribers to the Nelson project purchased their solar panels at an upfront cost of $945, with no further payments required.

Participants also had the alternative of paying for every kilowatt-hour of power their panels produce over the solar garden's lifespan. As the panels generate electricity each month, customers receive "solar credits" as deductions on their electricity bill. The solar credits are calculated annually and are proportionate to their share of the solar garden's production. Over time, all of the subscribers will recoup their initial investment and continue saving money on their electricity bills.

The system feeds into the grid owned by the City's electric utility, Nelson Hydro. By January 2018, the system produced over 36,000 kWhs, which was half of the initial annual estimate. The project is relatively small in scale, and is expected to generate 70-75,000 kWh/year, - enough to power roughly seven households. It is important to note that B.C had a particularly long winter since the project was first launched and the estimated savings may therefore, be less than expected for the first year. The project is intended to test the model for future expansion.

In this particular project, the return on investment was not the major factor driving development. There was a strong collective commitment by individual investors and groups from the Nelson community to support clean energy in B.C. The panels were purchased by enthusiastic members which included local churches, homeowners, renters, and co-ops. The municipality of Nelson hopes that cities across Canada will embrace the solar garden concept and replicate this model in their jurisdictions. It is important to note that B.C's net-metering laws are relatively flexible and allow for solar credits to be annualized. Although net-metering laws are still under discussion in Ontario, the lessons learned from the successful implementation of Nelson's community solar farm can perhaps better influence decision-making when it comes to eventually implementing Ontario's net metering program.

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[43] BC Power smart. (2017).

[44] Forman, G. (2017). "Nelson, B.C. saves money with Canada's first community solar garden". David Suzuki Foundation.

Case 2: Community Solar Farm in New York

In 2016, the first shared solar community farm project was completed in Tompkins County, New York. The 29 MW system comprises of 1,140 solar panels and has a generating capacity of approximately 360 kW, which is sufficient to power 60 homes and local businesses. Before shared solar arrived on the scene, there were many Tompkins residents who wanted to use solar power, but were not able to make it work due to high upfront costs, planning and logistics. Renovus Solar, an Ithaca-based solar installer, partnered with a local non-profit organization, The Finger Lakes GrassRoots Festival, in order to host the project on a piece of land that they own. The installation is owned by a collective of 47 area households.

Renovus Solar worked with community members in order to identify suitable sites for installing solar panels (flat, south-facing, and electrically compatible) and conducted an informational session for the community. They notified community members of the benefits of being able to receive income from their land, defray tax costs, and help the environment. Several property owners responded, about 30 people signed up for the project, and a site was eventually selected. The built solar array feeds into the utility grid and offsets 100 percent of the power subscribers use at home. Residents' monthly bills are currently around $15. With the average monthly electricity bill in New York being $106, this translates to savings of approximately $1092 annually.[45] It is worth noting that the project is estimated to reduce 220 metric tons of GHGs every year.

The project builds on the Shared Renewable Initiative program in the state of New York that enables businesses, renters, and homeowners to set up shared solar projects. The goal of the program is to expand access to clean energy. The program allows customers to join together to share the benefits of local renewable energy projects.[46] It works in conjunction with net metering laws, which allow solar power credits to be annualized, where surplus electricity generated during the summer is carried over to winter. During the winter, solar is in short supply but the credits built up over the summer ultimately offsets the energy costs. The first phase of the program focused on promoting low-income participation and implementation of energy projects in areas of the grid that can benefit most from local power production.

Following the development of two community solar projects on the Grassroots' property, Renovus' next aim is to develop a similar project in the western part of Schuyler County.

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[45] New York Electricity Rates and Consumption. (2018). Residential electricity rates and consumption in New York. Electricity Local. Retreived from: https://www.electricitylocal.com/states/new-york/

[46] Nexus Media. (2016). "New York is bringing solar power to the masses".

Section 3 - Determining Feasibility for Implementation:

Case 1: Solar Farm in Nelson, B.C

STRENGTHS

- Estimated electrical output = 70-75,000 kWh/year (B.C Hydro highest step 2 electricity rate = 12.9C /kWh - therefore, $ generated = $75,000 X 12.9 = $967,500/year)
- Retain savings in the community by January 2018, system produced over half of the initial annual estimate (36,000 kWhs)
- Allow residents and members to reduce their energy bills
- Reduce energy consumption of the community
- Negligible GHG emissions
- Energy democracy - active resident participation

WEAKNESS

- High upfront capital costs - total project cost = $314,360 (residents paid 248*945 = $234,360)
- Intermittent solar power generation - B.C had a long winter since the project launched in 2017 - estimated electricity generation is less than expected for the first year.

OPPORTUNITIES

- Enable co-ops/municipalities to review results and develop toolkits for implementing similar community solar projects
- Scale up system and replicate across other jurisdictions
- Enable municipalities to reach their climate change targets/objectives

THREATS

- No third-party ownership, multiple purpose entity net metering policy in Ontario yet.
- Co-op governance structure - requires member interest in project.
- Financial viability? - payback period.

Case 2: Solar Farm in New York - Net Metering

STRENGTHS

- Resident's monthly bills reduced to \$15 (compare with \$106 average for monthly NY electricity bills = \$1092 annual savings).
- Project is estimated to reduce 220 metric tons of GHGs every year.

WEAKNESS

- High upfront capital costs
- Intermittent solar power generation

OPPORTUNITIES

- Enable co-ops/municipalities to review results and develop toolkits for implementing similar community solar projects
- Scale up system and replicate across other jurisdictions
- Enable municipalities to reach their climate change targets/objectives

THREATS

- No third-party ownership, multiple purpose entity net metering policy in Ontario yet.
- Co-op governance structure - requires member interest in project.
- Financial viability? - payback period.

Section 4 - Recommendations:

- (Pending workshop with municipalities for feedback and review)
- Reflect on CEP analysis of 22 municipalities across Ontario to guide decision making.
- Make recommendations based on municipal level of interest.
- Conclusion.

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Appendix B: District Energy Literature Review

Section 1 - Overview of District Energy/ CHP Planning in Ontario:

District Energy in Canada

Today, there are currently 150 district energy systems in operation across Canada.[47] The first district energy system was built in London, Ontario in 1880 to serve its university, hospital and government complexes. The nation's first commercial district heating system was developed in 1024 in Winnipeg's commercial core.[48] It is interesting to note that Canada also has one of the northernmost district energy systems located in the NorthWest Territories.

In Ontario, district energy systems are currently in operation in Markham, Windsor, Kingston, London, Ottawa, Barrie, Sudbury, Cornwall, Oshawa, Mississauga, and Hamilton. There are several district energy systems currently operating in Toronto, a few of which take on unique approaches. The University of Toronto first launched a district heating system in 1911, which serves most of the university campus.[49] York University is also equipped with a district energy system which has been operating since the 1960s.

Markham District Energy is a thermal energy utility owned by the City of Markham.[50] In addition to supplying heat and electricity, the system also has features that build energy resilience for the community. In emergency scenarios for instance, the combined heat and power system has the capability to maintain power and heat to over 4 million square feet of buildings in Markham, including its hospital, two high schools, and a community centre.[51]

A particularly interesting district energy system currently operating within Toronto's downtown core is Enwave's Deep Lake Water Cooling system that uses water from Lake Ontario to cool a network of more than 60 buildings in the downtown core.[52] This system first began supplying district heating to the downtown region in the early 1960s.

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47 Enwave Energy Corporation. (2013).

48 Enwave Energy Corporation. (2013).

49 City of Toronto. (2018). District Energy.

50 Markham District Energy Inc. (2018).

51 Markham District Energy Inc. (2018).

52 Enwave Energy Corporation. (2013).

Opportunities and Benefits:

There are several long-term benefits that are associated with installing district energy systems. First, they provide financially viable energy services in urban regions that have moderate to high energy use intensities.[53] According to Ottawa's Community Energy Transition Strategy report, the most convenient time to build or expand district energy systems is during the initial phase of developing new buildings, or during the planning process. This creates opportunities to replace existing facilities that may be outdated or in need of repairs.[54] Modern district energy systems which are based on supplying hot water can also improve the efficiency of the system. This centralizes the production of heating and cooling, offering various advantages in the form of increased efficiencies and achieving economies of scale. These systems can also offer customers the convenience of not having to worry about maintenance and repairs, as its services are managed by an external organization (co-op or municipally-owned utility) that operates the district system.[55]

Most modern district energy systems have the capacity to be expanded to future developments. This allows for the incremental development of communities in a cost-effective way by first prioritizing economically feasible locations, followed by connections to future developments that have lower energy use intensities.[56] Furthermore, they can also integrate multiple energy sources such as renewables and waste heat sources.

Perhaps most importantly, district energy systems can significantly reduce the GHG emissions profile of communities. A report by Natural Resources Canada shows that conventional geo-exchange systems can reduce energy consumption by up to 70 percent while heating and up to 90 percent while cooling.[57] Decreases in GHG emissions can be as high as 90%, according to research conducted by the Toronto Atmospheric Fund (TAF).[58]

Current policy environment and incentive programs for District Energy systems:

The implementation of district energy systems is highlighted as a high priority sustainable objective in the Community Energy Plans published by the City of Vaughan, City of Burlington, Halton Region, City of Windsor, and the Waterloo Region.[59] They are also

[53] City of Ottawa. (2017). "Energy Revolution: Ottawa's Community Energy Transition Strategy - Phase 1."
[54] City of Ottawa. (2017). "Energy Revolution: Ottawa's Community Energy Transition Strategy - Phase 1."
[55] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.
[56] City of Ottawa. (2017). "Energy Revolution: Ottawa's Community Energy Transition Strategy - Phase 1."
[57] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.
[58] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.
[59] Toronto Renewable Energy Co-operative. (2018).

referred to in municipal climate change actions plans. The City of Toronto's Climate Change plan, Transform TO for instance, outlines short term objectives relating to the development of district energy geoexchange systems.[60] This includes leveraging innovative financing mechanisms and dedicated funding for community-based sustainable initiatives and GHG reduction projects. It is also important to note that it highlights objectives for advancing low-carbon thermal energy networks.[61] Despite the incentive programs and actions plans mentioned in Community Energy Plans for district energy systems, there are various challenges and constraints with regards to developing them in Ontario. There are also limited multi-level government funding opportunities which provide the critical capital financing required for district energy systems.[62]

<u>Constraints and Challenges:</u>

The major challenges associated the implementation of district energy systems is primarily the lack of coherent and concerted policy framework amongst different levels of government.[63] This stems from a lack of awareness with respect to district energy technology, as well as inconsistent terminology used across different documents (ground source heat pumps, geoexchange, earth energy systems, thermal, etc).[64] Furthermore, existing policies have been stated to focus on individual use, as opposed to larger scaled developments. There are also legislative barriers and complicated approvals process. For instance, within the former City of Toronto Municipal Code, there are no provisions to allow for the installation and maintenance of proposed geothermal heating/cooling systems within the public right of way.[65] In addition, those wishing to alter existing geothermal systems are required to obtain an Environmental Compliance Approval from the Ministry of Environment and Climate Change.[66] Experts in the geoexchange and district energy industry have expressed that these new requirements place a regulatory burden on companies, further hindering growth of the industry. The incentive programs aforementioned are also restrictive in that they only target individual, smaller-scaled systems, as opposed to larger systems that can operate at a community scale.

The high upfront costs associated with district energy systems is also worth mentioning. This results in longer payback periods as opposed to alternative improvements to in-

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[60] Toronto Atmospheric Fund (TAF). (2017).

[61] TransformTO. (2018).

[62] City of Ottawa. (2017). "Energy Revolution: Ottawa's Community Energy Transition Strategy - Phase 1."

[63] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.

[64] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.

[65] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.

[66] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.

building systems.[67] In addition, the historically low natural gas energy prices in North America have hindered the uptake of district energy systems in residential and commercial markets.[68]

In addition to the challenges with legislative frameworks and policy around district energy, there are also technical challenges. Installing district energy systems in older communities poses a major burden due to the limited working space and the need to replace outdated infrastructure in order to establish new connections. In high density communities, there is the issue of installing piping in areas with complex and already-developed underground infrastructure.[69] This is further compounded by the need to obtain permission when establishing connections that cross property lines. Although the technology behind district energy can yield practical solutions for reducing GHGs and achieving energy democracy, the inherent challenge lies in the implementation process, where careful coordination and infrastructure planning is required to ensure effective system design and economic viability.[70] Because of these challenges, we recommend that this model only be considered for new greenfield developments, deep retrofits which involve excavation, and small-scale developments in rural and remote communities that typically rely on diesel generators.

Section 2 - Identifying Opportunities for ECB Project:

In identifying opportunities pertaining to district energy for the ECB project, a review of cases of what other co-ops, municipalities, and private developers are implementing elsewhere (primarily in the United States and Europe) was conducted. This phase of the project aimed to examine the challenges associated with relevant district energy projects, identify the lessons learnt, analyze the regulatory environment, highlight innovative financing mechanisms and governance structures, and finally evaluate the potential to replicate similar models in Ontario.

Similar to the examination process performed beforehand, an analysis of 22 Municipal Energy Plans was conducted in order to determine a baseline level of interest with respect to district energy as a sustainable energy initiative. It is important to note that district energy was referenced by various terms in most planning documents in the form of

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[67] City of Ottawa. (2017). "Energy Revolution: Ottawa's Community Energy Transition Strategy - Phase 1."
[68] City of Ottawa. (2017). "Energy Revolution: Ottawa's Community Energy Transition Strategy - Phase 1."
[69] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.
[70] City of Ottawa. (2017). "Energy Revolution: Ottawa's Community Energy Transition Strategy - Phase 1."

thermal energy, geothermal, combined heat and power (CHP), waste heat recovery/geo exchange systems, and cogeneration.

While the case studies examined did not include the participation of a cooperative organization, we feel there is an important role that co-ops could play in mobilizing community support, as well as in raising community financing. It is expected that the case studies will better inform decision making and provide valuable reference material when implementing similar systems.

For the **District Energy/ CHP** focus area, the following case studies have been selected for an in-depth review:

Case 1: Regent Park - District Energy Community System
Case 2: City of Toronto - Green13 - District Energy Project
Case 3: Denmark - District Energy Co-operatives

Case 1: Regent Park District Energy System

In 2005, planning was approved for the Regent Park Community Energy System. This comprises of a combined heat and power (CHP) plant located directly below a 22-storey tower in the community. This consists of boilers and chillers located in the base of the tower. This community-scaled district energy system is currently run by the Toronto Community Housing (TCH) as a joint venture, in partnership with Cortix Utilities, which is a leading industry expert in the area of district energy. TCH retains control of the energy centre through 60% ownership.

In 2006, the first construction of the first phase began and the energy centre began operating in 2009.[71] The system provides heating and cooling to more than 900 residential units (using large quantities of water), commercial retail spaces, and City of Toronto buildings and facilities. It is interesting to note that there are about four kilometres of insulated underground pipes for heating and cooling in each building.[72] The energy system services a diverse community with mixed uses and contains retail, commercial, institutional, and residential units. The scale of the system covers 2078 units on a 28 hectare site. This made a district energy system an attractive option to supply energy to

[71] Canmet Energy. (2009). “Community Energy Case Studies: Regent Park Toronto”. National Resources Canada.
[72] Crews P. (2010). “Regent Park Revitalization”. SABMag.

the community. It is estimated that the system will reduce the emission of GHGs by 8000 tonnes a year.[73]

The current value of the district energy system is valued at $1.5 million.[74] To run the district energy system, Toronto Community Housing invested $36 million and Corix Utilities invested $24 million.[75] FVB Energy Inc, a consultant company based in Vaughan, was responsible for preliminary engineering, construction support, and periodic review during the course of the development.

Even though the primary fuel of the system is natural gas, it is designed to incorporate power from renewable energy sources of energy such as solar and geothermal power in the future.[76] There is also the potential to sell excess electricity to the Ontario power grid through Toronto Hydro. In addition, the district energy system has the potential to be expanded to connect to future developments outside Regent Park and provide them with heating and cooling services. Lastly, it should also be noted that there are future plans to integrate cogeneration, which could produce up to five megawatts of power.[77]

Although a renewable energy co-operative was not involved during the development of the Regent Park District Energy System, the scale of the system, the implementation of a more energy-efficient plant which services multiple sectors, and the emphasis on building the community make this case study an ideal project that could be replicated in partnership with a municipality in Ontario. However, this would ideally involve cooperation with a private entity that can provide the technical expertise and knowledge during the course of development. The co-op could play the role of mobilizing community investment to cover the funding required to initiate the project. Due to the high upfront costs associated with district energy systems, it would likely require long-term debt financing. Once the development of the system has been completed, members could then be allowed to invest into the project.

[73] Crews P. (2010). “Regent Park Revitalization”. SABMag.

[74] Canmet Energy. (2009). “Community Energy Case Studies: Regent Park Toronto”. National Resources Canada.

[75] Crews P. (2010). “Regent Park Revitalization”. SABMag.

[76] Natural Resources Canada. (2009). “Community Energy Case Studies: Regent Park”.

[77] Canmet Energy. (2009). “Community Energy Case Studies: Regent Park Toronto”. National Resources Canada.

Case 2: Green 13 - Project Neutral: Junction Geo Project

On Tuesday May 17th, 2016, a Project Neutral and Green 13 held a meeting amongst community members from Ward 13 in order to brainstorm ideas to support the City of Toronto's sustainability plan. Green 13 is a group of residents from Ward 13 in the City of Toronto who are concerned about issues relating to climate change, human health and the environment, and aim to advocate policy and behavioural change with respect to sustainability.[78] Project Neutral is a volunteer-led grassroots initiative that aims to transition neighborhoods to carbon neutrality.[79] The organization works with existing community members in order to establish greenhouse gas baselines, build community capacity through workshops and partnerships, and identify actions that could result in reduced energy consumption and carbon emissions.

Upon completion of the brainstorming session, the top action plans that were identified includes plans to instal more renewable energy systems which may include geothermal, district energy, solar, and deep lake water cooling.[80] These systems were ideally preferred to be owned by the neighborhoods they served in order to transition towards a more decentralized model. During the session, it was recognized that district energy is a key component of Transform TO, which is Toronto's climate action plan. The objective of the plan is to reduce emissions from buildings and help the City reach its GHG reduction target of 80% by 2050. Buildings (commercial, industrial, and residential) account for more than half of GHG emissions in Toronto. In addition, there has also been feasibility studies conducted to identify more than 27 locations with the potential to support new District Energy Systems in Toronto.

The workshops and the concept regarding the implementation of community-based clean energy projects led to the development of the Junction Geo Project in Toronto. This project seeks to support residents in reducing GHG emissions from heating and cooling homes and bring district-based geoexchange systems to the Junction Area.[81] Junction Geo partnered with Groundswell Energy, a geoexchange utility company, to work on the technical feasibility study and to select a business model and policy framework to support the development of district-based geoexchange systems.[82] These systems comprise of a network of underground piping that harnesses geothermal energy.[83] They can also

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78 Green13Toronto.

79 Project Neutral. (2018). A Project of Tides Canada.

80 Robinson S. (2016). "Summary Report: Ward 13 Brainstorm for a Sustainable City."

81 Green 13. Junction Geo.

82 Green 13. Junction Geo.

83 City of Edmonton. (2018).

capture waste heat from sewer networks. Green 13 also consulted with Toronto Region Conservation Authority (TRCA) to initiate the development of a Sustainable Neighborhood Action Plan (SNAP) and a Community Energy Plan (CEP). In addition to the organizations aforementioned, Green 13 was also supported for this project the Atmospheric Fund (TAF), which provided technical support and the City of Toronto, which provided the data required for the feasibility study.[84]

Moving forward, Green 13 began a close collaboration with the Public Good Initiative (PGI), which is a public policy consultancy connected with the University of Toronto's Public Policy Graduate Program.[85] The PGI team conducted extensive research on district geoexchange systems and produced a comprehensive report titled: "*Implementing District geoexchange Systems in Canada: An Examination of Opportunities and Constraints*".[86] This report provided a wealth of information on the operational and financial costs associated with implementing district-based geoexchange systems.

Interviews with district energy experts showed that pricing estimates at for an average house required at least $35,000 for retrofitting and installing the loop.[87] The report also looks at the available funding programs and incentives that are available at different levels of government, as well as supporting policy frameworks with respect to implementing district energy systems.

The PGI report also highlighted best practices and recommended options for the Junction Geo project. Strategies for limiting the upfront costs of district energy/geoexchange systems in Ward 13 include developing energy systems that operate at a community-scale. Furthermore, because of the relatively high upfront costs associated with district energy systems, the report recommends partnering with municipal bodies in order to secure benefits for communities through section 37 of the Planning Act. This section permits the City of Toronto to authorize increases in permitted height and/or density through zoning bylaws in return for community benefits, provided that there are relevant Official Plan policies in place.[88] Developing district energy systems could therefore be a strong incentive for developers and communities alike. As such, the report recommends that Green 13 collaborate with city planning staff in order to tap into these potential sustainability benefits, given the increasing development occurring within the district.[89]

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[84] Green 13. Junction Geo.

[85] Green 13. Junction Geo.

[86] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.

[87] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.

[88] City of Toronto. (2018). Section 37 Benefits.

[89] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.

Given that Ward 13 consists of a large number of heritage single family homes, it was also recommended that the community energy system be connected to the houses for heating and cooling purposes in order to reduce the baseline energy footprint of the neighborhood. This would reduce the maintenance and operation costs of the geoexchange system for residents (they would only be required to pay the connection and retrofit costs).[90] Lastly, the report provides a comprehensive overview of the major constraints and challenges for developing district energy projects. This information helped to determine the feasibility for implementing these systems across Ontario. With advancements in technology, these community-based energy systems could eventually become more financially tempting for homeowners and developers alike. Although the Junction Geo Project has yet not materialized, a similar model could be adopted by a renewable energy co-operative in partnership with a local municipality and private company specializing in district energy to embark on a similar venture.

Case 3: Denmark - District Energy Co-operatives:

In Denmark, there has been a long history of community owned energy supply. Power production was generally based on the non- profit principle, while electrical power production was owned by consumer cooperatives and municipalities.[91] Community, cooperative, and joint venture municipal and cooperative ownership structures have provided democratic legal structures for the Danish model to disperse and localise its energy services system. The Danish law emphasizes “right to invest” principles. This system requires project developers to give local residents priority when it comes to financing a community energy plan.[92] The effect of this principle has yielded numerous benefits for communities, as members were given a higher stake in an given project, thereby reducing the risk of foreign buyouts and ensuring quality-control.

Today, district energy and combined heat and power (CHP) is widely implemented across most Danish towns and is the largest source in terms of heat supply, with over 60 percent of space heating derived from these sources.[93] Approximately three quarters of the

[90] Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.

[91] Community Power for People’s Ownership of Renewable Energy. European Union.

[92] Balch, O. (2015). “Energy co-ops: why the UK has nothing on Germany and Denmark” The Guardian.

[93] Community Power for People’s Ownership of Renewable Energy. European Union.

district heating networks are owned by their consumers, with just over a quarter owned by local authorities.[94]

The Danish District Heating Association comprises of more than 400 companies which have a 99 percent supply of district heating to provide heating services for approximately 1.7 million Danish homes.[95] In addition to municipally-owned companies, a large proportion of Danish district heating companies are operated as co-ops. It is estimated that there are around 340 companies that are owned by consumers. With the majority having a non-profit model, these co-ops not only create an efficient heat supply but also offer consumers the lowest possible price. These co-ops provide low finance loans for local communities to implement district energy systems, potentially enabling them to save two tonnes of carbon dioxide savings per household per annum.[96] With Denmark aiming to heat 70% of all households with District Energy systems by 2020, this co-operative approach can feasibly help the country's efforts to expand clean energy systems and meet its climate change targets.[97]

One community heating project that is interesting to note uses a wood pellet district heating system in the Town of Gjern Varmecaerk. The system serves a local school, most local homes in the area, a small industry, and an indoor swimming arena that uses about one-fifth of the heating capacity.[98] It has a heating capacity of 5 MW and uses hot water to supply heat. The system services 490 customers and the plant is very compact in size, thereby making it unintrusive when it came to integrating it within its setting. Residents who own homes in Gjern are required to pay 26,000 Danish kroners (about $4,700 US), to connect to the district system.[99] The system is owned by its customers as a cooperative. Under Danish law, district heating systems that serve communities are not allowed to earn a profit, or establish a reserve fund. With typical homes costing approximately two million Danish Krones (which is equal to $360,000 US), the connection fees that homeowners pay to link with the neighborhood district system can equal about 8% of their home's purchase price.[100] Gjern Varmevaerk is just one of hundreds of compact

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[94] Conaty, P. Mayo, E. (2012). "Towards a Co-operative Energy Service Sector". Journal of Co-operative Studies, 45:1, 46-55.

[95] Jessen, K. (2015). "District Heating in the Danish Energy System". Green Energy.

[96] Monaghan, P. (2017). "Energy co-ops are on the rise – and they are coming together to innovate". Thenews.

[97] Jessen, K. (2015). "District Heating in the Danish Energy System". Green Energy.

[98] Biomass Energy Resource Centre. (2009).

[99] Biomass Energy Resource Centre. (2009).

[100] Biomass Energy Resource Centre. (2009).

biomass district heating systems that have benefited from Denmark's coherent national energy policy towards building a sustainable future.

A project that directly involved a municipality and a co-op is the Danish workers cooperative

http://www.coolheating.eu/images/downloads/2_Per-Alex-Sorensen.pdf

Section 3 - Determining Feasibility for Implementation:

Case	1) Regent Park District Energy System	2) City of Toronto - Green 13 District Energy System	3) District Energy Co-ops in Denmark
Interest in Ontario for Implementing Similar Project	✓		
Conducive regulatory environment in Ontario	✗	✗	✗
Dedicated funding sources	✓	✓	✓
Does not require external funding	?	?	?
Challenges with implementation	✓	✓	✓
Financially Viability	?	?	?
Potential municipal/coop partnership			

<u>**Case 1: Regent Park Community District Energy System:**</u>

STRENGTHS

- System is estimated to reduce the emission of GHGs by 8000 tonnes a year.
- Energy and cost savings - cash flow retained within community.

WEAKNESS

- General lack of research and development on district energy in Canada.
- Co-op governance structure - requires member interest in project.
- Large scale redevelopment of Regent Park resulted in gentrification of long-time residents.

OPPORTUNITIES

- District energy highlighted as a priority sustainable action strategy in most community energy plans.
- Opportunities for integration into newly planned suburban/greenfield developments.
- System is 'future proof' in that it can be extended to future developments - there are future plans to integrate cogeneration - which can produce up to 5 MW of power.
- It also has the ability to integrate renewable energy generation.

THREATS

- High upfront costs associated with district energy systems.
- High technical skill and engineering expertise required - will need to partner with private company - this can threaten the financial viability of the project (particularly with for-profit companies who want to retain ownership).
- System depends on natural gas - current gas prices are economically viable.
- Complicated zoning/permitting and approvals process due to scale.
- Legislative barriers - general lack of coherent and coordinated policy framework regarding district energy.
- Existing incentive programs target individual small scale systems - this makes it difficult to scale up projects at the community level.

Case 2: Project Neutral: Junction Geo

STRENGTHS

- GHG reductions
- Energy savings - geoexchange systems reduce maintenance and operation costs for residents.

WEAKNESS

- General lack of research and development on thermal energy and district energy in Canada.
- Co-op governance structure - requires member interest in project.

OPPORTUNITIES

- District energy highlighted as a priority sustainable action strategy in most community energy plans.
- Actions identified in brainstorming session outlined desires to integrate renewable energy systems - this provides opportunities for scaling the project (future proofing).
- Section 37 of the *Planning Act* can allow municipalities to secure benefits and incentivise developers and communities alike to develop district energy systems - through the authorization of increases in height/density.

THREATS

- High upfront costs associated with geo-exchange systems - even with incentive programs for homeowners.
  - Estimated cost of $35,000 for retrofitting and installing geoexchange loop systems in individual households.
- Complicated approval processes with respect to zoning/permitting.
- High technical skill and engineering expertise required - will need to partner with private company - this can potentially threaten the financial viability of the project (particularly with for-profit companies who may want to retain ownership).
- General lack of coherent and coordinated policy framework regarding district energy.
- Legislative barriers - existing incentive programs target individual small scale systems - this makes it difficult to scale up projects at the community level.

Case 3: District Energy Co-ops in Denmark

STRENGTHS

- GHG reductions and energy savings.
- Co-ops provide low finance loans for local communities to implement DE systems.
- DE systems in Denmark are owned by its customers as a cooperative.

WEAKNESS

- General lack of research and development on thermal energy and district energy in Canada.
- Co-op governance structure - requires member interest in project.
- Different regulatory environment in Ontario - RE co-ops are limited in their ability to distribute electricity.

OPPORTUNITIES

- District energy highlighted as a priority sustainable action strategy in most community energy plans.
- Opportunities for integration into newly planned suburban/greenfield developments.
- System is 'future proof' in that it can be extended to future developments - there are future plans to integrate cogeneration - which can produce up to 5 MW of power.
- It also has the ability to integrate renewable energy generation.

THREATS

- High upfront costs associated with district energy systems.
- High technical skill and engineering expertise required - will need to partner with private company - this can threaten the financial viability of the project (particularly with for-profit companies who want to retain ownership).
- System depends on natural gas - current gas prices are economically viable.
- Complicated zoning/permitting and approvals process due to scale.
- Legislative barriers - general lack of coherent and coordinated policy framework regarding district energy.
- Existing incentive programs target individual small scale systems - this makes it difficult to scale up projects at the community level.

Section 4 - Recommendations:

- (Pending workshop with municipalities for feedback and review)
- Reflect on CEP analysis of 22 municipalities across Ontario to guide decision making.
- Make recommendations based on municipal level of interest.
- Conclusion.

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Biomass Energy Resource Centre. (2009). Retreived from: https://www.biomasscenter.org/images/stories/gjern.pdf

Canmet Energy. (2009). "Community Energy Case Studies: Regent Park Toronto". National Resources Canada. Retrieved from:

Crews P. (2010). "Regent Park Revitalization". SABMag. Retrieved from: http://www.sabmagazine.com/blog/2010/10/06/regent-park-revitalization/

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Green 13. Junction Geo. Retrieved from: http://www.green13toronto.org/sites/default/files/files/Green13-PGI-FinalReport.pdf

Loewen E, Chan J, Smolinski M, Kotzer J. (2017). Green 13 - Public Good Initiative Final Report.

Natural Resources Canada. (2009). "Community Energy Case Studies: Regent Park".

Robinson S. (2016). "Summary Report: Ward 13 Brainstorm for a Sustainable City."

Appendix C: Energy Efficiency Literature Review

Section 1 - Review of Energy Efficiency Planning in Ontario and Europe

There are a few energy co-operatives in Canada which provide energy efficiency services. While there are many co-ops across Canada that are actively involved in energy, to date, the vast majority have focused on renewable energy production rather than energy efficiency. The few examples of co-ops engaging in energy efficiency did so by offering energy literacy training to members to reduce consumption.

For instance, The Community Energy Co-op of New Brunswick (CEC) is a community-based co-op which invests and participates in renewable energy and energy efficiency projects in New Brunswick.[101] Its main services include the installation of renewable energy systems, home and business energy consultations, and the development of educational programs and workshops to build capacity and raise awareness on energy conservation.[102] The Hearthmakers Energy Cooperative based in Kingston, Ontario is another non-profit cooperative that focuses on community-based business operations in the field of renewable energy and energy efficiency in Ontario.[103] Currently, the co-operative focuses its efforts on conducting energy audits, developing energy saving programs, and offering limited small-scale energy efficiency upgrades such as insulation and air sealing services.[104] The cooperative finances its services through the 'Home Reno Rebate' program, which provides financial rebates from Union Gas to its customers.

Although analysis of co-ops providing energy efficiency services in Canada yielded limited results, our research discovered a thriving network of renewable energy cooperatives in Europe that provide energy efficiency services.

<u>RES Co-op:</u>
The European Federation of Renewable Energy Co-ops (RESco-op) is a growing network of around 1250 energy cooperatives and their one million citizens who are facilitating the

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[101] Community Energy Cooperative. (2010).

[102] Community Energy Cooperative. (2010).

[103] Simko M, Beaulne M. (2012). "Heartmakers Making Kingston More Sustainable one Home at a Time". Kingston this Week.

[104] Red Squirrel Conservation Services.

transition towards clean energy.[105] Their objectives are to achieve energy democracy, promote REScoop business models throughout Europe, empower citizens to actively engage in RE projects, and build a more sustainable energy system. REScoop launched the REScoop Plus in 2011. It is a three-year EU-funded project that promotes energy efficiency as an important value creating activity for businesses across Europe.[106] The project involves energy co-ops (such as France's enercoop and Belgium's ecopower) across eight countries and aims to build a toolbox to enable other co-ops to implement energy efficiency services to their members. The objectives of the program seek to identify best practices and to carefully scrutinize them in order to build viable tools for energy co-ops across Europe.

The REScoop Plus program is built on the knowledge gathered and network established during the REScoop 20-20-20 project from 2012 to 2015.[107] This project served to foster close collaborations across all the actors involved in the energy market in Europe. The objectives were to identify the barriers for energy coops that differ from country to country, examine why the barriers are there, explore and measure best practices, and find solutions in order to develop more cooperative models. The Rescoop project also served to build a platform for promoting the idea of cooperative production to renewable energy in Europe, introduce the concept in countries where it has not yet been developed, and share its findings with other coops based in Europe.[108] The key components of the REScoop project were to explore research issues and to design business models for developing and managing REScoop cooperatives projects. Citizen-led projects are often subject to communication challenges. REScoop sought to identify these barriers and empower citizens by giving them the tools to spread the results, while stimulating enthusiasm and interest with respect to REScoops. The project also extended to research behavioural changes when it comes to energy management and approaches to energy efficiency.[109] The ultimate goal of REScoop 20-20-20 was therefore, to contribute to a new vision for the European Union energy market and develop a collective understanding with respect to the barriers faced by REScoops.

Moving forward, the objective of REScoop PLUS program is to make REScoops in Europe go beyond their assigned roles that include producing and supplying energy, and take the next step by generating energy savings for their members, forming a new pillar in their

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[105] REScoop. (2017).

[106] Monaghan, P. (2017). "Energy co-ops are on the rise – and they are coming together to innovate". Thenews.

[107] European Commission. (2017). "REScoop PLUS".

[108] REScoopVideos. (2012). "What is the role of REScoop 20-20-20 Project?".

[109] European Commission. (2017). "REScoop PLUS".

organisation.[110] On this note, it is important to note that there are several pilot projects under development that seek to evaluate the viability of generating energy savings. The results of these projects have produced varying degrees of success. Data research shows that among members, REScoops can achieve up to 20% energy savings.[111] Revenues generated from RE projects can also be used to finance energy efficiency measures in public buildings.[112] Furthermore, the program seeks to explore innovative business models that support energy savings for consumers. In the case of energy efficiency for instance, some REScoops have paid for insulation material for public buildings, while others pay the wage of a local energy expert who helps citizens and the local municipality improve their overall energy efficiency. The ultimate goal of the REScoop PLUS program is therefore, to develop a toolkit with a range of best practice products such as communication tools, as well as to share the acquired knowledge with other REScoops in order to facilitate the development of community power projects and energy efficiency services in Europe.

CITYnvest -

Another Europe-based project which focuses on building capacity with respect to energy conservation is CITYnvest. The project oversees the implementation of new business models for energy efficiency and aimts to create energy savings across three regions in Belgium, Bulgaria, and Spain. Its main objectives are to support and replicate innovative financing models for implementing energy efficiency retrofit projects in buildings.[113] They also aim to share their experience and knowledge through a set of guides, toolkits and training materials in order to guide local authorities and regional authorities to undertake energy efficiency renovations. The project conducts the large scale capacity building program through a series of workshops that aim to train more than 650 local authorities and 300 other stakeholders across 10 countries.[114] Investments that are made within the CITYnvest framework are monitored. The data that is collected from local authorities across the pilot regions is then analyzed in order to determine key success factors.[115]

CITYnvest namely looks at business models which are based on Energy Performance Contracting (EPC), Third Party Financing (TPF), revolving funds, soft loan schemes, and cooperative models that are developed across the European Union. These models have

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[110] European Commission. (2017). “REScoop PLUS”.

[111] Monaghan, P. (2017). “Energy co-ops are on the rise – and they are coming together to innovate”. Thenews.

[112] European Federation of Renewable Energy Cooperatives (REScoop).

[113] CITYnvest. (2018).

[114] CITYnvest. (2018).

[115] CITYnvest. (2018).

proven to be successful in providing financing for large scale and deep energy efficiency renovations in buildings.[116] Yet, they have not been widely implemented across Europe. Because local authorities are typically well-positioned to play a critical role in implementing these models, CITYnvest aims to help them in kick-starting energy efficiency retrofits in public buildings.[117] The project ultimately hopes to establish a foundation for investments in energy efficient deep renovations of public buildings, shape regulations and policies at the local, national and European level, and create sustainable jobs.

<u>Financing options, rebates, and incentive programs for energy efficiency retrofits in Ontario:</u>

In order to determine the feasibility of implementing energy efficiency retrofit projects in Ontario, it becomes necessary to examine existing financing programs that are available at different levels of government.

In Ontario, there are several incentive programs, grants and rebates that are accessible to organizations wishing to offer energy efficiency services. At the federal level, there is the Clean Growth Program under Natural Resources Canada, which provides up to $49.3 million in funding to develop and implement new building codes, to retrofit existing buildings, and build new net-zero energy consumption buildings across Canada.[118] These funds will support research, development and demonstration projects to facilitate the development and adoption of energy efficient technologies, building design and construction practices, provide more cost effective building solutions, and build confidence with industry professionals and experts to accelerate their adoption of revised building codes. The 'Green Municipal Fund' under the Federation of Canadian Municipalities (FCM) also provides funding for energy efficiency-related projects.[119] The FCM grants funding for research studies that aim to improve energy efficiency and reduce the GHG emissions profile of municipal facilities. However, it is important to note that there is a certain set of criteria for being awarded grants. Firstly, the study would have to have the potential to demonstrate a 50% reduction of GHG emissions from existing baseline levels.[120] The program awards up to $175, 000 of grant funding based on eligible

[116] CITYnvest. (2018).

[117] CITYnvest. (2018).

[118] Government of Canada. (2018).

[119] Federation of Canadian Municipalities. (2018).

[120] Government of Canada. (2018).

costs and $1 million for demonstration projects, which are also required to demonstrate a 50% reduction in GHG emissions.[121]

It is worth noting that the FCM is also looking to sign projects that requires a collaboration with municipalities.[122] It is thus a viable source of funding for a potential co-op and municipal partnership project. This competition provides funding of up to $1 million for projects that focus on improving energy efficiency, as well as for renewable energy production initiatives.

At the Provincial level, there are multiple sources of financing available, thanks in part to Ontario's new Climate Change Action Plan (2016-2020).[123] This provides up to $3.8 million for new grants, rebates, and subsidy programs to help improve the energy efficiency of buildings, transition them off conventional carbon fuels, and switch their source to geothermal and solar. According to the Climate Change Action Plan, a new Green Bank will administer these programs and provide various financing options. GreenON is a non-profit agency of the government of Ontario that provides millions in funding and grants for individual homeowners, small businesses, and organizations wishing to reduce their energy consumption. The funding is generated through proceeds from Ontario's carbon market.[124] GreenON is tasked with reducing GHG emissions from buildings and industries to help Ontario meet its climate change targets. They also provide low-income programs, funding for social housing buildings, affordable housing programs, and incentives to upgrade heating systems.[125]

At the municipal level, there is the Better Buildings Partnership Program (BBP) administered by the City of Toronto. Through the program, the City provides resources and financial assistance to help building owners and developers to reduce the energy consumption of their buildings and maintain high energy performance.[126] This program will be further examined in detail in Section 2.

A few alternate financing options that are worth noting are Tax Increment Project financing (TIF) and On-bill financing. TIF is a public financing model that has been used by

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121 Government of Canada. (2018).

122 Federation of Canadian Municipalities. (2018).

123 Government of Ontario (2018). "Ontario's Five Year Climate Change Action Plan 2016-2020". Queen's Printer for Ontario.

124 GreenON. (2018).

125 GreenON. (2018). "Programs for my organization".

126 City of Toronto. (2018). "Better Buildings Partnership".

various cities in the United States to fund infrastructure, redevelopment, and community-improvement projects. This model can also be used to create economic development through loans to property owners to implement efficiency-related improvements to their property. Building owners agree to a higher tax assessment based on the increased property value that occurs as a result of the project.[127] To implement a TIF, cities designate a specific area such that owners of buildings located within the immediate area would be eligible for financing. TIF eligibility varies according to respective state laws.[128] It is worth noting that TIF has been used to fund energy efficiency projects throughout the states, including small business improvements, commercial building audits and retro-commissioning, and investments at the district level including combined heat-and-power.[129] In Toronto, there is the question of whether this public infrastructure financing tool can be extended for the implementation of energy-efficiency retrofit projects, as well as renewable energy production facilities.

On-bill financing can also be used as a viable financing tool for residential buildings. It comes in the form of low-cost loans that are repaid through the participating co-op member's electric bills. Co-ops can run these programs to create benefits in the form of reduced per capita energy use and peak load shaving, which can help avoid the need for new power generation facilities and help meet energy reduction goals.[130] This allows co-op members to improve their homes with no upfront costs and to save money even while repaying the loan. These programs have been shown to increase member satisfaction with their co-op.[131]

Benefits and challenges: Energy Efficiency Co-ops

There are several benefits for co-ops in administering energy efficiency services. Because co-ops are community orientated and householder-owned with no external shareholders, they have the edge when it comes to community retrofit projects.[132] There is also the added benefit of sharing resources and disseminating the knowledge gained from implementing energy-saving approaches. Research has also shown that through energy-efficiency retrofits, local communities benefit through increased economic activity in the

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[127] 2030 Districts.org. (2018). Tax Increment Project Financing.

[128] 2030 Districts.org. (2018). Tax Increment Project Financing.

[129] 2030 Districts.org. (2018). Tax Increment Project Financing.

[130] Environmental and Energy Study Institute.(2017). "On-Bill Financing for Public Power". EESI.

[131] Environmental and Energy Study Institute.(2017). "On-Bill Financing for Public Power". EESI.

[132] Birch, S. (2013). "Energy co-ops are cutting household bills alongside carbon emissions". The Guardian.

service area and region, including job creation, as well as cost savings that are retained within the community.[133]

However, it is important to note that there are various issues when it comes to co-ops implementing energy efficiency retrofit projects. First and foremost is the significant upfront capital that is often required for retrofitting older buildings. Furthermore, according to an expert, the issue of 'trust' is one of the biggest challenges in the retrofitting industry. This is because of the split incentive that pitches owners against tenants. Lastly, the lack of strategic approaches, poor forums for communication and knowledge transfer, and weaknesses in the areas of finance in policymakers' understanding all pose considerable challenges for energy co-ops to implement retrofit projects .[134]

Section 2 - Identifying Opportunities for ECB Project:

This phase of the ECB project entailed reviewing case studies involving co-ops that provide energy efficiency services. This spanned jurisdictions in Canada, the United States, and Europe and examined initiatives within the public, private, and non-profit sectors. This process sought to understand the challenges associated with conducting energy retrofit projects, analyze the regulatory environment, identify financing mechanisms, and ultimately evaluate the potential to replicate a similar project in Ontario.

An analysis of 22 Municipal Energy Plans based in Ontario revealed that energy efficiency is regarded as a high priority sustainable initiative for reducing GHG emissions in communities across Ontario. It is important to note that most municipalities recognize that existing building stocks accounts for almost a quarter of Canada's total GHG emissions.[135] This is likely why most municipalities regard energy efficiency as a high priority climate change initiative, as they have outlined strategic initiatives towards bolstering building codes, introduced energy literacy workshops for community members, and developed energy retrofit action plans within their energy planning documents.

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[133] Monaghan, P. (2017). "Energy co-ops are on the rise – and they are coming together to innovate". Thenews.

[134] Conaty P. Mayo Ed. (2012). "Towards a Co-operative Energy Service Sector". Journal of Co-operative studies.

[135] Canada Emissions Trends Report. (2014).

For the **Energy Efficiency** focus area, the following case studies have been selected for an in-depth review:

Case 1: Pajopower
Case 2: Better Buildings Partnership Program (BBP)
Case 3: Sustainable Neighborhood Action Plan (SNAP) - TRCA

<u>Case 1: Pajopower</u>

Pajopower is a renewable energy sources cooperative (REScoop) based in Flanders, Belgium. The cooperative was founded in 2014 as a Belgian cooperative that aims to support sustainable development in Belgium.[136] The cooperative provides consultancy services by means of independent energy experts who conduct energy audits upon request. These audits serve to better inform retrofit projects by prioritizing the energy efficiency measures required for specific buildings/homes.

The cooperative issues shares and invests in renewable energy and energy efficiency projects in “hetPajottenland” and “de Zennevallei”, two regions South of Brussels.[137] All citizens are eligible to join the cooperative. After purchasing a share, citizens become co-owners of the projects and share in the profits.[138] Pajopower reaches out for both local citizens and local municipalities and helps them to improve the energy efficiency of their buildings, thereby helping them to reduce GHG emissions and reach their climate change targets. For financing energy efficiency services involving public buildings, Pajopower uses third party financing.

An interesting project they recently spearheaded involves the large-scale retrofitting of streetlights in Halle, a municipality South of Brussels. The project was delivered in collaboration with its founder, the NGO “Kyoto in het Pajottenland”.[139] Initially, the municipality lacked the financial capacity and found it difficult to secure funding from banks. The investment was financed by the the co-op, which issued shares and raised capital from local citizens who were invited to “adopt their personal street light”. In the

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[136] Creupelandt D, Vansintjan D. (2018). “Mobilizing European Citizens to Invest in Sustainable Energy. REScoop MECISE.
[137] Creupelandt D, Vansintjan D. (2018). “Mobilizing European Citizens to Invest in Sustainable Energy. REScoop MECISE.
[138] Creupelandt D, Vansintjan D. (2018). “Mobilizing European Citizens to Invest in Sustainable Energy. REScoop MECISE.
[139] Creupelandt D, Vansintjan D. (2018). “Mobilizing European Citizens to Invest in Sustainable Energy. REScoop MECISE.

end, the cooperative managed to raise 225,000 euros from local citizens. It then provided the municipality with a soft loan to make the investment. In total, it retrofitted 445 public streetlights in 2 towns South of Brussels. The LEDs save the city 400,000 kWh per year and approximately 92 tonnes of carbon dioxide emissions.[140]

Pajopower is also taking action to improve the energy efficiency of public buildings such as local schools and community centres. For public buildings, they issue shares and use third party financing to generate funding in order to finance energy efficiency measures.[141] There exists similar subsidised facilitation programs for private citizens. This is planned to be replicated and upsized by Ecopower, another Belgian-based cooperative that provides services in energy efficiency and renewable energy production. This initiative is a part of the REScoop MECISE (European Mutual for Energy Communities Investing in a Sustainable Europe) project.[142] REScoop MECISE aims to gather funding and take ownership in local renewable energy and energy efficiency projects. This also entails supporting a local energy community to aggregate funding from local citizens, municipalities, and institutional investors. The ultimate goal of the project is to provide technical assistance on the implementation of energy efficiency for authorities in order to help them reduce GHG emissions, as well as facilitate the transition towards decentralised renewable energy systems across Europe.[143]

Case 2: Toronto - Better Buildings Partnership (BBP) Program

With Toronto's buildings generating approximately half of the city's GHG emissions, the BBP program has helped the city to reduce its overall carbon footprint. To date, the BBP has helped develop more than 2,600 projects across Toronto, resulting in 3.8 million MWh in energy savings and 690,000 fewer CO2 emissions.[144] The program provides low interest financing to municipal divisions, agencies, community-based entities, and not-for-profits that aim to initiate energy retrofits.[145] The interest rate provided is at the City's cost of borrowing and is a fixed rate for the length of the funding agreement with a payback

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[140] Creupelandt D, Vansintjan D. (2018). "Mobilizing European Citizens to Invest in Sustainable Energy. REScoop MECISE.

[141] CITYnvest. (2017). Model 26: Cooperative Case Study: Pajopower.

[142] Creupelandt D, Vansintjan D. (2018). "Mobilizing European Citizens to Invest in Sustainable Energy. REScoop MECISE

[143] Creupelandt D, Vansintjan D. (2018). "Mobilizing European Citizens to Invest in Sustainable Energy. REScoop MECISE

[144] City of Toronto. (2018). "Better Buildings Partnership".

[145] City of Toronto. (2018). "Better Buildings Partnership.

period of up to 20 years.[146] Eligible projects include lighting retrofits, HVAC upgrades, and building envelope assessments.

The BBP program also offers energy efficiency incentives through the High Performance New Construction Program (HPNC).[147] This program offers incentives to building owners and designers to build beyond Building Code requirements and help them offset the cost of making their buildings more energy efficient. For business owners, the program covers up to $10,000 for modelling costs and up to $800 per kilowatt of verified savings.[148] Eligible buildings include commercial, institutional, industrial, or multi-residential buildings which include schools, educational buildings, hospitals, and hotels. It is important to note that conditions outlined in the program require that construction must comply with the Ontario Building Code, and that the building must be operational and deliver kWh savings on or before December 31st, 2020.[149] With buildings generating about half of the GHG emissions in Toronto today, these programs can facilitate further energy efficient retrofits and potentially help the city meet its GHG reduction targets.[150]

This financing program can work in conjunction with cooperative goals which aim to: facilitate the development of the community power sector, build capacity when it comes to community-scaled energy efficiency retrofits, and ultimately shift energy management processes into community hands.

There are several existing energy efficiency programs/initiatives across Ontario that are similar to the BBP program. In Oakville, a total project budget of $12 million was included in the 2016-2017 capital budget and was projected to be fully offset by the savings achieved through LED conversion.[151] The City of Markham's Environmental Sustainability Fund also provides financial assistance to improve the energy efficiency of its buildings through initiatives and pilot projects.[152] Vaughan's Municipal Energy Plan outlines the development of the Residential Energy Conservation and Efficiency Retrofit Program, which aims to develop and implement coordinated energy conservation and retrofit programs that target existing households to promote and increase participation in energy conservation at home.[153]

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[146] TAF. (2017)."Energy Efficiency Financing Tools for the Canadian Context".

[147] Toronto Hydro-Electric System limited. (2018).

[148] Toronto Hydro-Electric System limited. (2018).

[149] City of Toronto. (2018). Energy Efficiency Incentives.

[150] City of Toronto. (2018). Energy Efficiency Incentives.

[151] Town of Oakville. (2018).

[152] City of Markham. (2017).

[153] City of Vaughan. (2016). Vaughan Municipal Energy Plan.

With strong municipal interest with regards to energy efficiency retrofit projects, a co-op-municipal partnership could potentially yield beneficial results due to strong overlapping interests and objectives. The Pajopower case examined beforehand could be replicated to retrofit municipally owned buildings in Ontario. Renewable energy co-ops could contribute third party financing to existing municipal energy programs such as the BBP program. In partnership with municipalities, the co-op can also tap into funding provided by the Federation of Canadian Municipalities (FCM) to implement community-scaled energy retrofit projects and/or develop energy literacy workshops to interested members. Such ventures can facilitate the growth of energy retrofitting services and build capacity for authorities to implement energy conservation projects.

Case 3: SNAP - Toronto Region and Conservation Authority (TRCA)

The Toronto and Region Conservation Authority (TRCA) developed the Sustainable Neighborhood Action Plan (SNAP) to help municipalities improve efficiencies, aggregate local community support, and form partnerships at the local level.[154] Because the conservation authority implements a range of climate change urban renewal initiatives in the public and private sector, it also hopes to build trust for long-term engagement with communities. The program attempts to examine and develop the process for neighborhood-wide sustainable retrofits. It also aims to guide strategic infrastructure investments that will implement watershed and municipal plans, along with climate change strategies at the ground level.[155]

To date, SNAP neighborhood projects include the development of neighborhood action plans for 6 communities in Markham, Mississauga, Toronto, Richmond Hill, Caledon, and Brampton.[156] These programs aim to improve the efficiencies of neighborhoods, initiate urban renewal projects, and implement climate change adaptation strategies.

Retrofit projects implemented by SNAP are typically funded by government grants and subsidy programs, which are part of the proceeds from Ontario's carbon market. For the West Bolton region in Toronto, the Government of Ontario awarded a grant to SNAP for the design and implementation of a Home Retrofit Program in West Bolton.[157] This project aimed to test methods of increasing the number of suburban homes undertaking Home Energy Retrofits with the aim of reducing overall residential energy consumption and the

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[154] Toronto Region and Conservation Authority. (2018).

[155] Toronto Region and Conservation Authority. (2018).

[156] Toronto Region and Conservation Authority. (2018). SNAP Neighborhood Projects.

[157] Toronto Region and Conservation Authority. (2018). Home Retrofit Program.

associated GHG emissions. It is interesting to note that each SNAP neighborhood features unique characteristics which are based on the existing conditions of the neighborhood. In the Black Creek community for example, localised basement flooding and erosion as long been an issue. As such, SNAP initiatives include flood water protection measures, exploration of renewable energy sources, and naturalization projects to restore stream conditions.[158] These initiatives complement measures to improve the energy efficiency of homes within the neighborhood.

It is also worth noting that SNAP offers workshops and information sessions for homeowners wishing to improve their energy efficiency. In 2012, TRCA launched a program which conducted an extensive ‘green makeover’ of homes in order to showcase the benefits of eco-friendly homes, educate homeowners and the building industry about installation and maintenance, and demonstrate the impact of green home renovations.[159] These programs aim to build capacity and develop the technical skill set of homeowners and authorities to better implement and manage community-scale energy efficiency projects.

Furthermore, there are also incentive-based renovation programs that are offered by SNAP/TRCA which provide funding for energy efficiency renovations and sustainable urban renewal solutions. These come in the form of available `grants for home energy audits and unlimited solar assessments for qualifying homes.[160]

Given that co-ops have close relationships with communities at the local level, similar programs can be launched in partnership with municipalities. Co-ops can leverage their expertise to mobilize relevant stakeholders and local groups in order to aggregate community investment and support the implementation of energy efficiency renovations at the community-scale. They can also work alongside municipalities to develop develop cohesive action plans to build resilience within their neighborhoods.

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[158] Toronto Region and Conservation Authority. (2018). SNAP Neighborhood Projects.

[159] Toronto Region and Conservation Authority. (2018). Projects: Green Home Makeover.

[160] Sustainable Neighbourhood Retrofit Action Plan (SNAP) Projects. (2013).

Section 3 - Determining Feasibility for Implementation:

Case	1) Pajopower	2) Better Buildings Partnership Program	3) SNAP
Interest in Ontario for Implementing Similar Project	✓		✓
Conducive regulatory environment in Ontario	✓	✓	✓
Dedicated funding sources	✓	✓	✓
Does not require external funding			
Challenges with implementation	✓	✓	✓
Financially Viability	?	?	
Potential municipal/coop partnership	✓		✓

Case 1: Pajopower

STRENGTHS

- Energy savings - LEDs save city 400,000 kWh per year
- GHG reduction - 92 tonnes of CO2 emissions.
- Increases awareness on energy conservation and energy efficiency
- Residents attracted by 'adopt a streetlight campaign'

WEAKNESS

- Co-op governance structure - requires member interest in project.

OPPORTUNITIES

- Existing financial assistance programs in Ontario available for energy efficiency projects - grants, incentive programs, rebates (GreenON).
- Strong municipal/provincial interest in implementing energy efficiency initiatives.

THREATS

- High upfront costs associated with retrofitting older communities in Ontario.
- 'Split incentive' issue that pits owners against tenants.

Case 2: Better Buildings Partnership (BBP) Program

STRENGTHS

- To date, BBP has implemented 2600 projects across Toronto.
- Energy savings - 3.8 million MWh.
- GHG reduction - 690,000 fewer CO2 emissions.
- Increases awareness on energy conservation and energy efficiency.
- Reasonable fixed rate of interest.

WEAKNESS

- Co-op governance structure - requires member interest in project.

OPPORTUNITIES

- Existing financial assistance programs in Ontario available for energy efficiency projects - grants, incentive programs, rebates (GreenON).
- Strong municipal/provincial interest in implementing energy efficiency initiatives.
- HPNC Program incentivises homeowners and developers to implement energy efficiency measures.
- Existing energy efficiency programs in Ontario align with co-op objectives and BBP program.

THREATS

- Questionable ownership model - shared ownership with City? - limited stake for members?
- High upfront costs associated with retrofitting older communities in Ontario.
- 'Split incentive' issue that pits owners against tenants

Case 3: Sustainable Neighborhood Action Plan (SNAP)

STRENGTHS

- Mobilizes community support (and potential investments).
- Program has community-wide focus - ideal for co-op.
- Energy savings.
- GHG reduction.
- Increases awareness on energy conservation and energy efficiency.

WEAKNESS

- Co-op governance structure - requires member interest in project.

OPPORTUNITIES

- Existing financial assistance programs available in Ontario for energy efficiency projects - grants, incentive programs, rebates (GreenON).
- Strong municipal/provincial interest in implementing energy efficiency initiatives.

THREATS

- High upfront costs associated with retrofitting older communities in Ontario.
- 'Split incentive' issue that pits owners against tenants.

Section 4 - Recommendations:

- (Pending workshop with municipalities for feedback and review)
- Reflect on CEP analysis of 22 municipalities across Ontario to guide decision making.
- Make recommendations based on municipal level of interest.
- Conclusion.

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2030 Districts.org. (2018). Tax Increment Project Financing. Retrieved from: http://www.2030districts.org/toolkit-sub-category/tax-increment-financing-tif2030%20Districts.org.%20(2018).%20Tax

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Appendix D: Energy Storage Literature Review

Section 1 - Battery Storage Systems - Ontario

With falling costs of batteries and energy storage technologies, the energy landscape in Ontario is changing, with a greater focus on efficient, clean and reliable methods of energy generation to meet electricity demand and reduce GHG emissions. There is also growing interest for increasing grid-connected renewable generation.[161] Both of these technologies can help Ontario's efforts to reduce its GHG emission target of 80% below 1990 levels by 2050 and build a low-carbon economy.[162] There are several energy storage projects that have been implemented in Ontario. These have started out initially as pilot projects but have now progressed to developing energy storage systems at the commercial scale. The National Energy Board's July 2016 Market Snapshot on energy storage in Canada reported that over 50 megawatts (MW) of battery capacity is expected to be operational in Canada by 2018. This accounts for approximately 81% of the total electricity storage market.[163] It is interesting to note that flywheel energy storage accounts for another 11% of the total electricity storage market.[164]

The Independent Electricity System Operator (IESO) led the procurement of 56 MW of new energy storage projects through contracts in the province of Ontario.[165] These projects aimed to demonstrate how storage technology applications can provide a number of benefits including, grid reliability, cost savings, and the increased adoption of intermittent renewable generation resources. The IESO started the pilot projects in 2012 and was was able to successfully procure 6 MW of responsive energy storage through a phased approach. Building on this success, the IESO then proceeded to procure an additional 50 MW of storage.[166] The projects have led to a better understanding of the

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[161] City of Toronto. (2017). "Energy Storage Strategy".

[162] Government of Ontario. (2017). "Ontario's Climate Change Strategy. Queen's Printer of Ontario.

[163] Stephens D., Chung J. (2017). "Energy Storage Developments in Canada, the U.S, and Beyond the Last Twelve Months. Aird & Berlis LLP.

[164] Stephens D., Chung J. (2017). "Energy Storage Developments in Canada, the U.S, and Beyond the Last Twelve Months. Aird & Berlis LLP.

[165] City of Toronto. (2017). City of Toronto Energy Strategy.

[166] City of Toronto. (2017). City of Toronto Energy Strategy.

different types of energy storage technologies and the opportunities and constraints associated with developing grid-connected energy storage applications.[167]

There are a number of energy storage projects currently operating in Ontario. Powin Energy, a company that manufacturers battery storage systems, recently partnered with Hecate Energy, to build, deliver, and install Canada's biggest energy storage project.[168] The project is planned to have a total capacity of 12.8 MW and 52.8 megawatt-hour at two sites in Ontario.

Storage system developer Convergent Energy + Power also recently completed construction of a 7 MW energy storage system located in the City of Sault Ste. Marie, Ontario. The IESO plans to monitor the ability of the system to collect, store, and release energy into the grid over the next three years.[169] Upon successful completion of the project, it is expected that the technology could be deployed across the province to provide more reliable, effective, and affordable energy across Ontario's electrical grid over time. The projects were all contracted with the IESO as part of their procurement process.[170]

Niagara-on-the-lake Hydro is another great example of a battery system that can promote peak demand management and improve grid reliability. The project is currently in progress and it is hoped that the system will make capacity available at specific feeder and enable greater distributed energy resource uptake.[171] Once implemented, the technology will be analyzed in order to confirm optimal use. The system is also expected to increase the adoption of renewable energy technologies within the region and allow customers to take part in community energy projects.

Toronto Hydro has also been developing energy storage projects which aim to defer expensive infrastructure renewal costs and meet the growing demands of the city. The second largest municipal electricity distribution company in Canada is currently collaborating with Metrolinx and Renewable Energy Systems Canada (RES) to develop community-based projects in constrained areas. One recent project involves the installation of large-scale lithium battery systems to support the new Eglinton Crosstown

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[167] City of Toronto. (2017). City of Toronto Energy Strategy.

[168] Stephens D., Chung J. (2017). "Energy Storage Developments in Canada, the U.S, and Beyond the Last Twelve Months. Aird & Berlis LLP.

[169] Stephens D., Chung J. (2017). "Energy Storage Developments in Canada, the U.S, and Beyond the Last Twelve Months. Aird & Berlis LLP.

[170] Stephens D., Chung J. (2017). "Energy Storage Developments in Canada, the U.S, and Beyond the Last Twelve Months. Aird & Berlis LLP.

[171] Government of Ontario. (2018). "Energy Storage". Queen's Printer for Ontario.

LRT.[172] The approximately 20 MW project will store surplus power generated off peak across Ontario during the night when electricity rates are cheap. It will then supply the energy during the daytime to reduce peak energy use and lower the Crosstown's overall GHG emissions and operating costs. The system is also expected to provide emergency power for up to four hours in the event of power disruptions.[173] As these examples show, Canada's energy storage market is beginning to take off.

Current Policy Environment for Energy Storage in Ontario:

In Toronto, there are a number of city-wide initiatives that align with energy storage technologies. City growth and development plans such as TOCore and the Toronto Green Standard introduced new regulations that outline initiatives for a low carbon economy.[174] These include the development of micro grids and net zero buildings. Energy storage systems can play a key part here since micro grids and net zero buildings rely on quick dispatch of low carbon energy sources. By taking advantage of energy storage systems, homeowners and/or local energy providers can use the stored low carbon energy during periods of peak demand or when the system's renewable generator is unavailable. This can lead to cost savings and reduced emissions over the long term.

The TransformTO 'Leading by Example' strategy for internal City facilities also highlights the opportunity to tap into energy storage applications in order to meet the City's sustainability objectives and reach its climate change targets. These strategies evaluate the potential of energy storage solutions to provide energy savings and reduced emissions for ratepayers. It is worth noting that the high value of energy storage has driven many US cities and states to set 2020 energy storage targets.[175]

With authorities gradually recognizing the key role that energy storage can play in our electricity systems, there are certain legislative changes that are were recently made in Ontario in order to encourage storage development. For instance, Ontario's net metering regulation (0 Reg 541/05) was amended on July 1st, 2017 in order to allow renewable energy generation facilities of any size with an energy storage component to be eligible for net metering.[176] This was previously not permitted. However, given that the Ontario's

[172] Stephens D., Chung J. (2017). "Energy Storage Developments in Canada, the U.S, and Beyond the Last Twelve Months. Aird & Berlis LLP.

[173] Stephens D., Chung J. (2017). "Energy Storage Developments in Canada, the U.S, and Beyond the Last Twelve Months. Aird & Berlis LLP.

[174] Stephens D., Chung J. (2017). "Energy Storage Developments in Canada, the U.S, and Beyond the Last Twelve Months. Aird & Berlis LLP.

[175] City of Toronto. (2017). "Energy Storage Strategy".

[176] Stephens D. Chung Jasmine. (2017). "Canada: Energy Storage Developments in Canada, the U.S, and Beyond in the Last Two Months." Aird Belris.

net metering regulation is currently being revised, it is possible that there may be certain limitations and/or conditions for projects moving forward.

It is also important to note that there are current regulatory issues when it comes to developing energy storage systems in Ontario. Behind-the-Meter generation in Ontario for instance is currently unregulated. This creates various limitations and challenges when it comes to developing energy storage systems.

Opportunities for Co-ops and Municipalities to Undertake Energy Storage Projects:
With anticipated decreases in the costs of energy storage technologies, the value in peak demand shaving and infrastructure investment deferral is beginning to be recognized across the energy sector.[177] Renewable energy cooperatives, as well as municipal-owned electric systems can benefit from the increasing trend towards energy storage technologies and distributed generation. Instead of viewing this transition as a threat to traditional utility business models, municipally-owned utilities can perhaps leverage the increasing consumer interest in DER and renewable energy. Big consumers of energy in the manufacturing, commercial real estate, and other sectors are demanding green sources of power.[178] Co-ops and municipalities could leverage this demand as an adaptive response, as opposed to private corporations. Because they are not required to cater to stockholder interest or navigate through regulatory constraints, they are well-positioned to make this transition.[179]

Such partnerships can provide customers with more options, thereby increasing competition within the energy sector. Combined with the flexibility offered by energy storage, these systems can also be used for community-oriented conservation initiatives such as demand response programs, voltage regulation, and to optimize overall system efficiency.[180]

Section 2 - Identifying Opportunities for ECB Project:

In identifying opportunities for the ECB project, a review of successful cases of energy storage systems being implemented by other co-ops, municipalities, and private

[177] Maloney, P. (2017). “Colorado electric co-op rolls out 'community battery' program”. Utility Dive.
[178] Palk, R. (2018). “Why Cooperatives and Municipal-owned Electric Systems Should Embrace Distributed Energy Changes”. Electric and Light Power.
[179] Palk, R. (2018). “Why Cooperatives and Municipal-owned Electric Systems Should Embrace Distributed Energy Changes”. Electric and Light Power.
[180] Maloney, P. (2017). “Colorado electric co-op rolls out 'community battery' program”. Utility Dive.

developers (primarily in Canada, the United States, and Europe) was conducted. It is important to note that energy storage systems come in many forms: batteries, compressed air, flywheel, thermal energy storage, and hydrogen. These are being researched through various projects in Ontario. For the purposes of the ECB project, our research focused on battery storage due to the extensive research and development behind the technology, its scalability, familiarity, and the projected falling costs of battery storage technology in the coming years.[181]

This phase of the project served to identify the major obstacles associated with implementing battery storage systems, identify the lessons learnt, examine the regulatory environment, explore financing mechanisms, and ultimately determine the potential to initiate the deployment of battery systems in Ontario through a co-op/municipal led initiative.

In order to gauge the level of interest with respect to energy storage, an analysis of 22 Municipal Energy Plans was conducted. The results indicate that energy storage is a low priority climate change strategy across most municipalities. However, given the projected falling costs of battery storage technology, such systems may likely become an attractive option for utilities and authorities wishing to conserve energy and better integrate renewable energy systems.

For the **Energy Storage** focus area, the following case studies have been selected for an in-depth review:

Case 1: Community Battery Systems: United Power and Connexus Energy – Colorado
Case 2: Saturn Power Project – Stratford
Case 3: Brooklyn Microgrid - New York

Case 1: Community Battery System: United Power/ Connexus Energy

United Power Electric Co-op is a not-for-profit electric cooperative based in Colorado. It is owned by the customer-members who receive electricity from them. They are governed by a member-elected board of directors, who direct the operations of the cooperative, oversee needed rate changes, and help the staff and employees plan for the future of the company.[182] Back in 2017, United Power Cooperative and SoCore Energy, a

181 International Renewable Energy Agency. (2018). “Electricity Storage and Renewables: Costs and Markets to 2030.”
182 United Power. (2015). Retrieved from:

solar developer announced plans to build the largest energy storage facility in Colorado.[183]

The 4 MW, 16 MWh battery storage system in Firestone, Colorado, will store energy generated over night and discharge it during the day to reduce demand charges. The storage system is the first of several energy projects the cooperative is planning as part of its “community battery” strategy that lets members of the cooperative share the battery system’s output to reduce demand charges on their monthly electric bills. Similar to a community solar program, customers are able subscribe to the program. However, instead of getting a credit for power generated, subscribers are awarded a credit to offset their peak demand. The program is open to anyone, but it mostly aimed at commercial and industrial customers.[184]

Although the total investment was not disclosed, United Power was reported to have committed “millions” to the project. It is worth noting that United Power does not have its own generation. Instead, it buys power wholesale from Tri-State Generation and Transmission Association. United Power estimates that commercial and industrial customer could pay back their subscription investment in about 10 years. Even if no customers sign up for the program, the coop claims that the batteries would cut its peak demand and repay the investment in seven or eight years with a 10% return.[185]

Depending on the results of the project, United Power hopes to develop similar projects moving forward. With the refinement of battery storage technology, longer duration batteries will eventually be able to generate peak demand savings, while changing the economics of the project.

Connexus Energy

Another similar energy storage system is currently under development in Minnesota by the state’s largest electric cooperative called Connexus Energy. The not-for-profit cooperative provides electricity and related services to member residents and businesses.[186] The cooperative is a member of Great River Energy (GRE), a wholesale electric service provider that serves more than 28 cooperatives in the state of Minnesota and serves approximately 685,000 members in various counties across the state.[187]

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[183] Maloney, P. (2017). “Colorado electric co-op rolls out 'community battery' program”. Utility Dive.

[184] Maloney, P. (2017). “Colorado electric co-op rolls out 'community battery' program”. Utility Dive.

[185] Maloney, P. (2017). “Colorado electric co-op rolls out 'community battery' program”. Utility Dive.

[186] Connexus Energy. (2018).

[187] Great River Energy. (2018). A Touchstone energy Cooperative.

In 2017, the cooperative announced plans to install a storage system capable of storing 20 MW (40 MWh), potentially making it the largest system in the state.[188] Interest for the project first developed after a strategic planning meeting by the cooperative, where members expressed their desire to develop more renewable projects with distributed energy resources without adversely affecting rates. Connexus claims that the energy storage system could be expanded for various uses, including peak shaving and demand response.[189] It is worth noting that the co-op plans to include three solar installations that would be located at the battery storage sites. The collective output of the solar project is aimed to be around 10 MW.[190]

The result of the project will ultimately influence how storage can play a key role in Minnesota's community solar garden market. There are certain challenges that must be addressed however. Co-op managers expressed concern with respect to how the state's harsh winters and summer seasons will affect the performance of the battery systems.[191] The project therefore, also hopes to evaluate the versatility of energy storage technology.

In Ontario, a similar community battery project could potentially be implemented through a partnership between a co-op and a municipally-owned utility. This would enable the co-op to raise community investment for the project. This model would ideally work where peak pricing exists in order to take advantage of higher demand periods and generate savings.

Case 2: Saturn Power - City of Stratford

While behind-the-meter regulation still makes energy storage systems somewhat difficult to develop in Ontario, there has been some progress in this sector in recent years. Saturn Power is a developer in Ontario which has experience with energy storage. Their portfolio includes over $150 million in assets under management including approximately 100 MW of renewable generation.[192] They also have financial tools available to help provide capital for generation and storage projects.

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[188] Jossi, F. (2017). "Minnesota co-op plans state's biggest energy storage project". Midwest Energy News.

[189] Maloney P. (2017). "Connexus Energy planning Minnesota's Largest Energy Storage Facility". Utility Dive.

[190] Maloney P. (2017). "Connexus Energy planning Minnesota's Largest Energy Storage Facility". Utility Dive.

[191] Maloney P. (2017). "Connexus Energy planning Minnesota's Largest Energy Storage Facility". Utility Dive.

[192] Saturn Power. (2018).

In the City of Stratford, Saturn Power has plans to build one of the largest battery storage systems in Ontario. Announced in 2017, the project is being developed through a partnership between Powin Energy, Hectate Energy, and Festival Hydro (the city-owned utility provider).[193] The system will have a total capacity of 12.8 MWh and it will be combined with another in Kitchener, Ontario to provide services such as voltage control, frequency regulation, and improve grid reliability.[194] The facility located in Stratford will house four lithium ion battery cell arrays with a total storage capacity of 8.8 MW, which is expected to supply more than 10,000 homes with electricity for an hour.[195]

The system will charge energy from the grid at off-peak times, such as during the night when electricity rates are cheaper. During peak periods, it can then be used to deliver energy in order to reduce peak demand for the city's central generation system. It is expected that the system will generate savings over the long term since it would reduce the need to install the infrastructure required to manage the region's electric power supply system. It is hoped that such systems can strategically provide a more stable electric supply and lead to a more balanced load-low throughout the system.[196] The transition towards distributed energy sources would also lead to less dependence on central generation systems, thereby also helping to improve voltage stability.

The project is part of the Ontario Independent Electricity System Operator's (IESO) Long Term Energy Plan (LTEP) to facilitate the transition towards a low carbon economy. It also aligns with its objectives to provide support services such as voltage control and the reduction of energy demand through new energy storage technologies.[197] The IESO issued the contract with the goal of exploring how battery storage systems can be used within the overall electricity supply system. It is interesting to note that the testing facility is one of the first large-scale battery storage projects to go live in Ontario.

One of the project partners, Powin Energy (a private corporation that designs and developed energy storage solutions for utilities), provided $25 million in investment for the city's battery storage facility.[198] It is worth noting that Festival Hydro had developed a $15.8 million transformer station back in 2013. The recently developed battery storage

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[193] Simmons G. (2017). "Festival Hydro hosts grand opening ceremony for Canada's largest battery storage facility". Beacon Herald.

[194] Simmons G. (2017). "Festival Hydro hosts grand opening ceremony for Canada's largest battery storage facility". Beacon Herald.

[195] Simmons G. (2017). "Canada's largest battery storage facility to be built in Stratford". Beacon Herald.

[196] Simmons G. (2017). "Canada's largest battery storage facility to be built in Stratford". Beacon Herald.

[197] Simmons G. (2017). "Canada's largest battery storage facility to be built in Stratford". Beacon Herald.

[198] Simmons G. (2017). "Canada's largest battery storage facility to be built in Stratford". Beacon Herald.

facility is located on the same site.[199] This close proximity, as well as the fact that the local power distribution company (Festival Hydro) owns a transformer that has the capacity to take on this storage project, ultimately attracted the attention of Hecate Energy. This company is another developer of renewable energy systems and battery storage technologies. Ysni Semsedini, the CEO of Festival Hydro expects that the transformer station and the new battery storage facility will increase industrial and economic interest in Stratford.[200]

Case 3: Brooklyn Microgrid - Marcus Valley Village

The concept of community battery systems can be taken a step further by developing a community-powered microgrid. One such system is the experimental Brooklyn Microgrid in the Marcus Garvey Village community in New York that was designed by the startup tech company LO3 Energy.[201] LO3 Energy partnered with Siemens Digital Grid and Siemen's startup financier next47 to develop the project.[202] This demonstration project enables citizens to buy and sell locally generated solar power from one another and trade power among themselves across a blockchain enabled transactive platform.[203] The project started in early 2015, and in April 216, the first community activity took place when three residents of the community participated in the first ever peer-to-peer energy transactions. To date, community members can use an app in order to trade these 'energy credits'.

LO3 aims to use the success of the project to demonstrate the benefits of distributed energy sources.[204] These benefits include increased resiliency as the the microgrid operates independently from the larger grid during power outages. This can provide backup power during emergencies.[205] The project aims to develop a connected network of distributed energy resources and create financial incentives and business models to encourage community investment in local renewable energy generation.

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[199] Saturn Power. (2018).

[200] Simmons G. (2017). "Festival Hydro hosts grand opening ceremony for Canada's largest battery storage facility". Beacon Herald.

[201] Spector, J. (2017). "Brooklyn's social housing microgrid rewrites relationships with utility companies". The Guardian.

[202] Breuer, H. (2017). "A Microgrid Grows in Brooklyn".

[203] Breuer, H. (2017). "A Microgrid Grows in Brooklyn".

[204] LO3 Energy. (2018).

[205]Breuer, H. (2017). "New York neighbours power up blockchain-based Brooklyn Microgrid". SiliconRepublic.

The microgrid system comprises of rooftop solar energy systems which increases the supply of clean renewable energy generated locally.[206] Other components of the microgrid system include energy storage units and a fuel cell system in order to provide services such as peak load reduction, standalone backup power, and ensure grid reliability and stability. The fuel cell is based on natural gas and it supplies a steady supply of current during the day.[207] Both the solar and fuel cell systems produce a maximum of 400 kilowatts. The project's multi-family residential storage system comprises of lithium-ion batteries which have a capacity of 300 kW / 1,2 MWh.[208] These enable residents to store electricity during the night when rates are cheaper, thereby reducing peak energy demand and leading to cost savings. The components of the microgrid system cost approximately $4m to install.[209] However, it is important to note that they reduce the community's monthly bill by 10% to 20%, thereby helping to keep the housing cost affordable.

The microgrid was developed and is operated by Demand Energy, a software developer that focuses on developing intelligent software control platforms for energy storage and distributed generation networks. The platform is based on maximizing the economic returns of behind-the-meter storage systems that are used in combination with distributed generation.[210]

New York's utility company, Consolidated Edison (Con Ed), has an agreement to pay Marcus Garvey Village for using its stored energy to reduce demand on the grid at key periods, such as during hot days when residents turn on their air conditioning.[211] This reduction in local demand helps the utility to avoid the $1.2 billion costs associated with upgrading electrical infrastructure by using cheaper, localised services. This subsequently saves ratepayers money in the long run, while also enabling Con Ed to focus on other communities that have increasing energy demands.[212]

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[206] Breuer, H. (2017). "A Microgrid Grows in Brooklyn".

[207] Spector, J. (2017). "Brooklyn's social housing microgrid rewrites relationships with utility companies". The Guardian.

[208] Demand Energy. (2017). "Marcus Garvey Village Microgrid".

[209] Spector, J. (2017). "Brooklyn's social housing microgrid rewrites relationships with utility companies". The Guardian.

[210] Demand Energy. (2017). "Marcus Garvey Village Microgrid".

[211] Spector, J. (2017). "Brooklyn's social housing microgrid rewrites relationships with utility companies". The Guardian.

[212] Spector, J. (2017). "Brooklyn's social housing microgrid rewrites relationships with utility companies". The Guardian.

In terms of financing, it is expected that the project will more than pay for itself through a combination of incentives from Con Edison, along with continuous revenue generated through participation in demand response and peak shaving power programs.[213] In addition, the project was also financed with a 10-year non-recourse project loan by the New York City Energy Efficiency Corporation (NYCEEC).[214] NYCEEC is a non-profit finance company that offers loans and alternative financing solutions for energy efficiency and clean energy projects. The organization also formulated a financing approach which allowed a new business entity to own and operate the energy storage system profitably. The Village's owners, L+M Development Partners (a real estate company that develops mixed-income housing), and Demand Energy also agreed on a "shared savings" operating model to cover debt service and share in revenue generated, allowing them to collaborate to produce the greatest return possible.[215]

It is important to note that a key aspect of the project was to ensure that the Marcus Garvey Village community was able to self-consume all the energy it generates, without exporting to the grid. Future goals of the project include expanding it to be able to include 1,000 participants - including apartment houses, schools, a gas station, a fire station, and factory buildings. The project also plans to install more battery storage units and more extensive solar systems.[216]

213 Demand Energy. (2017). "Marcus Garvey Village Microgrid".

214 Demand Energy. (2017). "Marcus Garvey Village Microgrid".

215 Demand Energy. (2017). "Marcus Garvey Village Microgrid".

216 Breuer, H. (2017). "New York neighbours power up blockchain-based Brooklyn Microgrid". SiliconRepublic.

Section 3 - Determining Feasibility for Implementation in Ontario:

Case	1) United Power Community Battery System	2) Saturn Power	3) Brooklyn Microgrid
Interest in Ontario for Implementing Similar Project	?	?	?
Conducive regulatory environment in Ontario	✗	✗	✗
Dedicated funding sources			
Does not require external funding			
Challenges with implementation	✓	✓	✓
Financially Viability	?	?	?
Potential municipal/coop partnership			

Case 1: United Power - Community Battery System

STRENGTHS

- United Power estimates that customers can pay back their investment in 10 years. The coop claims that the batteries would cut peak demand and repay investment in 7 or 8 years with a 10% return.
- Will lead to less dependent on centralised generation systems.
- Energy + GHG savings.

WEAKNESS

- Questions arise regarding the recycling and safe disposal of batteries over the long term.

OPPORTUNITIES

- Model could work using a bill crediting system by not directly connecting individual households to the battery system.
- Depending on the project results, similar models can be replicated in other jurisdictions.
- Falling costs of batteries and storage technology will make the project more economically feasible in the near future.

THREATS

- High upfront capital costs.
- Co-op governance structure - requires member interest in project.
- Behind the meter may pose a challenge when integrating renewable energy generation into the system (such as rooftop solar panels), or expanding the system to incorporate distributed energy resources.

Case 2: Saturn Power Community Battery System

STRENGTHS

- System takes advantage of peak pricing in order to generate savings and reduce peak demand.
- System will reduce utility costs by deferring asset replacement.
- Project can provide a more stable electricity supply and lead to a more balanced load-low throughout the system.
- Improved voltage stability.
- Will lead to less dependent on centralised generation systems.
- Energy + GHG savings.

WEAKNESS

- Questions arise regarding the recycling and safe disposal of batteries over the long term.

OPPORTUNITIES

- Depending on the project results, similar models can be replicated in other jurisdictions.
- Falling costs of batteries and storage technology will make the project more economically feasible in the near future.
- The transformer and the new battery storage facility will increase industrial and economic interest in Stratford.

THREATS

- Behind the meter may pose a challenge when integrating renewable energy generation into the system (such as rooftop solar panels), or expanding the system to incorporate distributed energy resources.
- High upfront capital costs.
- Co-op governance structure - requires member interest in project.

Case 3: Brooklyn Microgrid

STRENGTHS

- Project demonstrates the benefits of distributed energy resources and blockchain technology.
- System allows residents to store electricity during the night when rates are cheaper, reducing peak energy demand and leading to cost savings.
- The system helped to reduce the community's monthly bill by 10-20%.
- Will lead to less dependent on centralised generation systems.
- System will reduce the $1.2 billion utility costs by deferring asset replacement - this will save ratepayers money in the long run.
- Improve grid reliability and stability.
- GHG reduction.

WEAKNESS

- Questions arise regarding the recycling and safe disposal of batteries over the long term.

OPPORTUNITIES

- Depending on the project results, similar models can be replicated in other jurisdictions.
- Falling costs of batteries and storage technology will make the project more economically feasible in the near future.
- Project is planned to be scaled up and install more battery storage units and more extensive solar systems.

THREATS

- Behind the meter rule in Ontario will inevitably pose challenges to replicate similar model.
- High upfront capital costs.
- Co-op governance structure - requires member interest in project.

Section 4 - Recommendations:

- Analyze CEPs of 12 municipalities in Ontario to guide decision making.
- Make recommendations based on municipal level of interest.
- Conclusion.

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Spector, J. (2017). “Brooklyn's social housing microgrid rewrites relationships with utility companies”. The Guardian. Retrieved from: https://www.theguardian.com/sustainable-business/2017/aug/17/energy-brooklyn-social-housing-microgrid-rewrites-relationships-with-utility-companies

Stephens D., Chung J. (2017). “Energy Storage Developments in Canada, the U.S, and Beyond the Last Twelve Months. Aird & Berlis LLP. Mondaq. Retrieved from: http://www.mondaq.com/canada/x/618844/Oil+Gas+Electricity/Energy+Storage+Developments+In+Canada+The+US+And+Beyond+In+The+Last+Twelve+Months

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Appendix E: Demand Response Literature Review

Section 1 - Review of Demand Response Programs in Ontario:

What is Demand Response?

Demand Response (DR) programs provide an opportunity for consumers to play a role in the operation of the electric grid by shifting their electricity usage during peak periods.[217] DR enables electricity consumers to reduce their electricity consumption in response to changes in prices and electrical system needs.[218] During peak periods when the power system is experiencing a surge in demand, the market price of electricity is usually high. This places a greater risk on the reliability of the electricity grid. DR programs also help to reduce the need to bring on new capacity to manage these peak moments of electricity consumption (asset deferral). For example, during the summer, there are often peak moments that lead to brownouts due to surges in AC use. DR programs can enable consumers to reduce their energy demand during these periods and allow utilities to stabilize their grids. DR programs can also be incorporated into the cost management strategies of electricity customers and organizations. During peak periods, DR can play an important role in reducing businesses' energy consumption by curtailing the electricity usage of big facilities or switching to on-site generation.[219] Shifting production to an off-peak period is another great opportunity to take advantage of lower electricity costs.[220]

Actors within the electric power industry therefore see value in DR because of its potential as a valuable resource that can complement grid modernization efforts.[221] Battery storage technologies can also be combined with intelligent building management components to utilize automatic features in order to divert or switch power to mitigate peak load issues and power failures.[222] These can comprise of smart customer systems such as smart thermostats, in-home displays, or home area networks that provide customers with readily accessible information about their energy consumption. This can

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[217] Independent Electricity System Operator. (2018).

[218] Save on Energy. (2018). "Demand Response Program - A Powerful Opportunity to Manage Your Electricity Costs". Independent Electricity System Operator (IESO).

[219] U.S Department of Energy. (2018). "Demand Response".

[220] Save on Energy. (2018). "Demand Response Program - A Powerful Opportunity to Manage Your Electricity Costs". Independent Electricity System Operator (IESO).

[221] U.S Department of Energy. (2018). "Demand Response".

[222] U.S Department of Energy. (2018). "Demand Response".

make it easier for them to make behavioral changes to reduce their energy demand.[223] DR programs also have the potential to help electricity providers save money through reductions in peak demand and the ability to defer the construction of new power plants and power delivery system - specifically, those reserved for use during peak times.

Demand Response Programs in Ontario:

In Ontario, DR has been having a growing impact on energy demand and has helped to reduce peaks. This has made DR a valuable and cost-effective resource to Ontario's electrical system. It has been a useful tool for electric system operators as resource options to balance supply and demand. Ontario's Independent Electricity System Operator (IESO) for instance, has been exploring the potential of DR programs to provide grid benefits in recent years. Through a competitive procurement process, the IESO secured up 70 megawatts (MW) of DR from three companies representing 10 projects that range from 1 MW to 35 MW.[224] Each of these developments have unique technical characteristics, requirements and constraints. These pilot projects serve to provide valuable research data and help utilities find ways to develop new tools that adapt to changes in electricity consumption and help balance supply and demand.

As part of the ECB project, the research analysis examined various examples of demand response programs currently in effect in Ontario. This entailed an examination of municipal energy plans across Ontario. In the City of Markham's corporate energy plan (2014), there are several examples of DR programs that are helping authorities to reduce GHG emissions. The City already has two of its large facilities, the Markham Civic Centre and the Thornhill Community Centre enrolled in the Ontario Power Authority's (OPA) demand response programs. Markham's energy plan outlines strategies to increase DR participation and include other recreational facilities that have year-round ice rinks and buildings with natural gas generation.[225] The Halton Region Community Energy Plan also outlines several action plans including DR. These include the installation of building automation systems for the optimization of HVAC systems, as well as training programs for staff, energy, and maintenance officials.[226]

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[223] U.S Department of Energy. (2018). "Demand Response".

[224] Independent Electricity System Operator (IESO). (2018). "Markets and Related Programs."

[225] City of Markham. (2014). "Corporate Energy Management plan". Markham Energy Conservation Office.

[226] Halton Region Community Energy Plan. (2013).

Section 2 - Identifying Opportunities for ECB Project:

Similar to the previous focus areas, a review of successful cases involving DR programs being implemented by other co-ops, municipalities, or private companies (in Canada, the United States, and Europe) was conducted. This aimed to analyze the issues and challenges associated with implementing DR programs in Ontario, examine the regulatory environment, highlight innovative funding mechanisms and governance structures, and lastly determine the potential to replicate similar programs in Ontario through a co-op-led partnership. The results will help to guide decision making and act as reference material when proceeding with the later stages of the ECB project.

As with previous focus areas, an analysis of 22 Municipal Energy Plans (Corporate Energy Plan, Community Energy Plan (CEP), Sustainability Plan, and Climate Change Plans) was conducted. DR programs were found to be a low priority climate change strategy amongst most municipal CEPs. However, given the progression of distributed energy resource (DERs) and the falling costs of energy storage technology, DR can have significant potential to create savings and reductions in GHG emissions within communities. Our analysis of CEP plans came across DR programs in a variety of forms within municipal action plans such as peak energy reduction programs, aggregation of energy demand programs, microgrids, and building automation systems for municipally-owned buildings.

For the **Demand Response (DR)** focus area, the following case studies have been selected for an in-depth review:

Case 1: PowerStream POWER.HOUSE Project
Case 2: ECamion Battery Storage + EV Charging
Case 3: Pole-Mounted Energy Storage / IESO Pilot - Rodan's Energyshift (™) DR Program

Case 1: POWER.HOUSE - PowerStream

In Ontario, Alectra Utilities, which was formerly PowerStream, launched a residential solar storage pilot program in 2015, called POWER.HOUSE. This pilot project was funded by the IESO Conservation Fund and was designed to evaluate the economic and grid benefits that combined residential solar storage can bring to customers and the electricity system in Ontario. It examined the challenges associated with the widespread adoption of the POWER.HOUSE program in Ontario, with a specific focus on York Region. The IESO and Alectra Utilities planning staff worked together to estimate the value of deferring transmission and distribution investments, as well as determining the technical requirements and the operability the program would need in order to successfully defer upgrading energy infrastructure in Ontario.

As part of the program, 20 households each received a solar installation on their roof and a household battery system. The array of solar panels and 12 kilowatt-hour lithium ion battery were connected to a bi-directional meter. The idea of the program was that the solar panels will be used to charge a household battery. During peak consumption times such as during a hot days when people have their air conditioners turned on, the utility would switch these households from grid power to the energy stored in their personal battery. This project allowed participants to reduce a portion of the electricity they source from the grid, reduce energy costs, lower their carbon footprint, and better manage the electricity that they use. It is worth noting that Powerstream had control over their thermostats to control energy use under the terms of agreement with household owners.

With respect to cost savings, residents saved approximately $150 per month on their monthly electric bills by utilizing the rooftop solar systems. A comprehensive payback analysis found that a single family home would have to pay $4,500 per unit up front for the storage systems (or $80/month for 10 years), with a payback period of 4-5 years. For semi-detached/ row homes, the breakdown is $55/month for 10 years with a payback period of 5-6 years. This reflects a sustainable example of a model that could support widespread deployment.

The results showcase the benefits of residential storage can bring to residents, when managed through demand response programs in the form of software control platforms with aggregation capabilities. Benefits of the pilot included reduced energy costs, lowered carbon footprint, and improved efficiency. The system was also used by the utility to provide grid reliability and resiliency.

In ontario, a similar approach could be replicated by a RE co-op that acts as the aggregator in partnership with a municipally-owned utility company interested in expanding their demand response programs. This could be achieved by taking on the role of raising capital to cover expenses, such as purchasing and installing the thermostats and batteries. This also could be complemented with solar battery systems in order to bring retail energy customers together with the overall goal of reducing peak energy demand.

Case 2: eCamion - Electric Car Charging batteries and Demand Response

ECamion Inc. is a developer and manufacturer within the community energy storage industry. They specialize in the integration of battery systems with renewable energy systems such as solar and wind power projects, as well as off-grid and microgrid applications.[227] In 2009, eCamion opened their first facility in Whitby, Ontario. The following year, the company expanded its offices and established a research and development facility in Markham, Ontario. Since then, the company has developed a breadth of experience with respect to developing energy storage systems and microgrids.

Their products include a diverse range of community energy storage systems (CES), anti-idling and auxiliary power technology, charging stations, and on-site renewable energy technologies.[228] They also offer support for software platforms such as building management systems and utility smart grids in order to provide increased flexibility when it comes to implementing energy storage systems. To facilitate the implementation of these systems, the company also offers services in energy management consulting, financing, custom design, project management for different sectors, and provides strategic and policy advice to North America's energy markets and industries.[229] Further, the company provides financing, custom design, engineering.

ECamion's objectives are also to support the growth of EV charging infrastructure and offer solutions for utilities, automotives, and renewables. In 2017, eCamion teamed up with Natural Resources Canada and Leclanche, which is also another energy storage system developer based in Geneva, in order to install 34 electric vehicle fast charging stations along the Trans-Canada Highway.[230] The goal of the project is to expand the infrastructure for electric vehicles and encourage the adoption of zero-emission vehicles. The project is valued at $17.3-million and is planned to be installed in Ontario and Manitoba. This will enable drivers to charge their electric vehicles using charging stations that are powered by lithium-ion battery storage systems. According to the developers, this way, the charging stations will not stress local electricity grids as significant infrastructure upgrades for improved integration is not required.[231] The stations are planned to be equipped with level 3 chargers, which enables the rapid charging of electric vehicles in approximately 30 minutes. The project is funded through an $8-million "repayable contribution" from Natural Resources Canada under the Canadian Energy

[227] ECamion. (2014).
[228] ECamion. (2014).
[229] ECamion. (2014).
[230] ECamion. (2014). "Fast-charging electric vehicles coming to Trans-Canada Highway".
[231] ECamion. (2014). "Fast-charging electric vehicles coming to Trans-Canada Highway".

Innovation Program, as well as private investment from eCAMION and Leclanché.[232] Such projects are part of a federal-level effort to increase the number of zero-emissions vehicles on Canada's roads. With cities across the world transitioning towards electric vehicles (EVs), eCamion has identified several market opportunities for developing charging infrastructure.

However, it is worth noting that there are several underlying challenges associated with developing electric vehicle charging infrastructure. According to ECamion, these include high upfront capital costs and demand charges.[233] In the City of New York for instance, demand charges for power consumption above 5 kW averages out to over $26 per kW used. Depending on the level of charging provided, this would increase yearly operating expenses. In addition, large sections of the grid do not even have the necessary infrastructure in place to integrate fast charging stations. The process of negotiating with utilities, purchasing, and installing new grid equipment is expected to cost around $1,000,000-$5,000,000.[234] Furthermore, there is also the issue of uncertain revenue streams during the early EV adoption phase since the charging infrastructure being developed face inconsistent usage patterns, thereby posing a risk to investors.[235] A similar issue may present itself during the long term transition towards EVs, where the charging infrastructure in place today may be rendered obsolete with advances in EV battery technology and charging infrastructure over the coming years.

To address these issues, ECamion has developed an innovative universal charging system which comprises of multiple charging stations that are supported by a battery storage unit. This provides flexible charging speeds, improved monitoring, and the ability to check the availability of the charging stations and the EV charging status with the use of a mobile app. As the battery will supply most of the power, this will help to reduce demand charges. Moreover, there is no additional infrastructure or grid upgrades required since the eCamion system requires only a 50kW power consumption rate from the grid.

This provides various benefits in the form of both short term and long term stability. During the early adoption phase of electric vehicles, it can allow for a more stable revenue stream through demand response programs. Furthermore, it can also allow for the better integration with facilities such as energy storage systems in order to provide supplementary revenue, as shown in **Figure 1**.[236]

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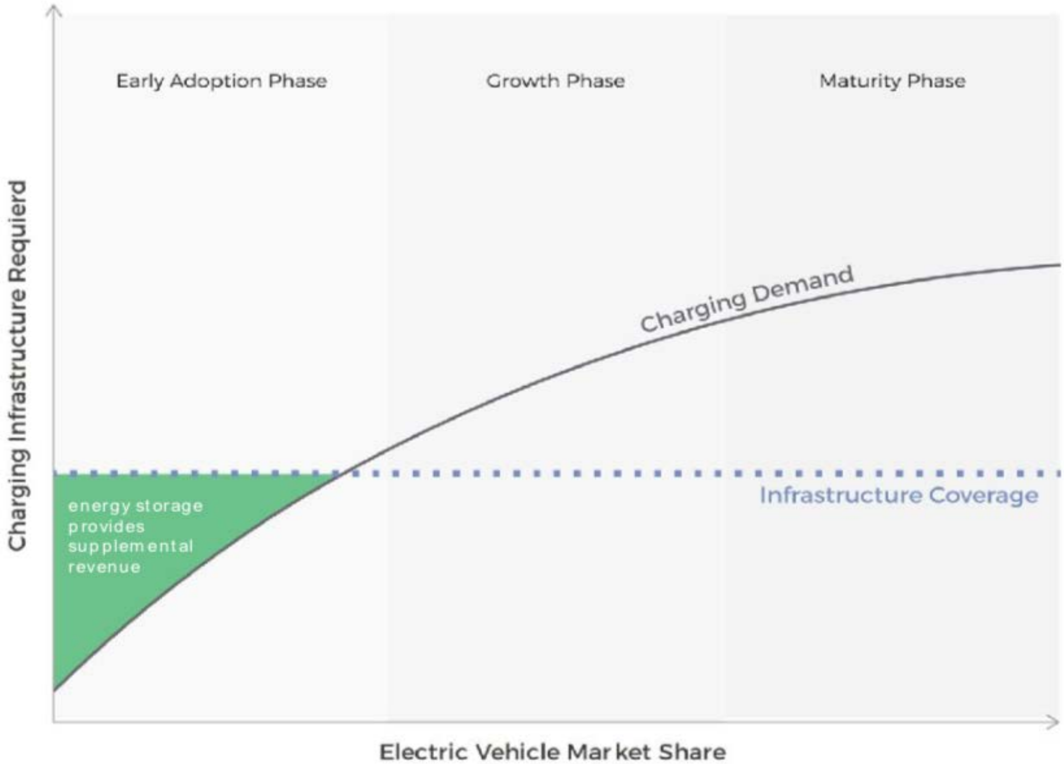
[232] ECamion. (2014). "Fast-charging electric vehicles coming to Trans-Canada Highway".
[233] ECamion. (2018). "Presentation on EV growth and market forecast".
[234] ECamion. (2018). "Presentation on EV growth and market forecast".
[235] ECamion. (2018). "Presentation on EV growth and market forecast".
[236] ECamion. (2018). "Presentation on EV growth and market forecast".

Figure 1: Short-term Revenue Stability[237]



Over the long term when the market for EVs has grown and matured, the universal charging system also provides various benefits since the charge ports support charging up to 350 kW and ultra-fast charging. This makes it a versatile system to keep up with developing charging technologies. Battery system upgrades can also be made over time in order to store greater capacity. As the demand for EV adoption increases and as EVs become more common over time, the revenue from EV charges will eventually become the main revenue source, as shown in **Figure 2** on the following page**.** This creates an attractive business model which has a payback period of approximately 3 years, with profits increasing steadily after the 4th year as revenue from EV charging grows (figure 2).

[237] ECamion. (2018). "Presentation on EV growth and market forecast".

Figure 2: Profit Breakdown[238]

Over the next several years into 2022, eCamion has a busy project pipeline, with $17.3 being invested into developing a charging network along the Trans Canada Highway and $4 million being invested into condo charging.[239] Furthermore, there are also plans to develop grid supportive EV charging infrastructure internationally starting in 2019. Used in conjunction with EV charging infrastructure, demand response programs can thus create viable business opportunities. RE co-ops can undertake a similar approach by acting as the project coordinator of demand response programs and taking on the responsibility of program coordination and implementation. The capital required for the initial rollout of the program and the installation of energy storage systems may financed with community investment tools administered by the cooperative.

Case 3: Pole Mounted Energy Storage

In 2017, Toronto Hydro launched a pole-mounted energy storage project in partnership with Ryerson University's Urban Energy and eCamion, which is a battery storage developer based in Ontario.[240] The Centre for Urban Energy (CUE) at Ryerson University

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[238] ECamion. (2018). "Presentation on EV growth and market forecast".

[239] ECamion. (2018). "Presentation on EV growth and market forecast".

[240] Alam, H. (2017). "Toronto Hydro, Ryerson launch pilot projects to store energy in pole-mounted compact box. The Star.

is an academic-industry partnership that explores and develops sustainable solutions to urban energy challenges that include the advancement of smart grid technologies and integration of energy storage, electric vehicles and renewables.[241]

With increasing urbanization and densification due to increasing population growth, there is the growing need to upgrade existing infrastructure to improve grid reliability for residents and meet national carbon emission targets. However, the amount of energy used by customers varies significantly throughout the day creating a need for flexible infrastructure to coop with the fluctuations in demand and supply. In dense urban settings, this creates certain challenges due to the space requirements associated with installing large-scale energy storage systems.[242]

The pilot project involved installing a small storage device up 6 metres on a hydro pole in the Keele street and lawrence street areas. The device can supplement electricity during peak hours in homes.[243]

In addition, the system takes advantage.Using eCAMION's modular storage solution, the pole-top unit charges during off-peak hours, takes advantage of unused space in urban areas and communicates with downstream smart meters of connected residences with a Ryerson developed smart controller.

Impact: This system will reduce the strain on distribution transformers by smoothing the daily electricity peaking cycle. Reliability for customers will be increased by the battery's ability to respond to real-time data, including an indication of an outage.
Organizations -

In a pilot project, a compact white box, a little bigger than a suitcase, has been mounted about six meters up a hydro pole in the Keele St. and Sheppard Ave. West area. It's paired with a 50 kilowatt transformer that typically powers about 12 houses.

Cost of units - $20,000 to 30,0000

Each of the 15kWh units aren't meant to provide bulk electricity to power houses but to provide support for a grid by making it more efficient.

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[241] Centre for Urban Energy. (2018). Ryerson University.

[242] Centre for Urban Energy. (2017). Pole-mounted energy storage. Ryerson University.

[243] Alam, H. (2017). "Toronto Hydro, Ryerson launch pilot projects to store energy in pole-mounted compact box. The Star.

The units are charged during off-peak hours, around 1am/2am - when transformers begin to see its biggest load during peak hours - the storage unit will supplement some of the energy. This will defer asset replacement.

Similar projects help to demonstrate deferring asset replacement costs by relieving the load on an overload transformer

Have a system where the coop owns the units - in partnership with a utility distribution company. It depends on how you define a utility. Vertically integrated utilities that combine generation, transmission, and distribution aren't suitable for a market in which customers can substantially fulfill the generation needs of the system locally. What we don't need is centralized planning, what we do need is coordination.

Rodan's Enershift DR Program - https://www.newswire.ca/news-releases/rodans-enershifttm-dr-program-launched-province-wide-535826541.html

Section 3 - Determining Feasibility for Implementation:

Case	1) POWER.HOUSE	2) ECamion EV Charging	3) Pole Mounted Energy Storage
Interest in Ontario for Implementing Similar Project	✓		
Conducive regulatory environment in Ontario	✗	✗	✗
Dedicated funding sources	?	?	?
Does not require external funding			
Challenges with implementation	✓	✓	✓
Financially Viability	?	?	?
Potential municipal/coop partnership			

Case 1: POWER.HOUSE

STRENGTHS

- System is estimated to reduce the emission of GHGs by 8000 tonnes a year.
- Energy savings.

WEAKNESS

- General lack of research and development on thermal energy and district energy in Canada.
- Co-op governance structure - requires member interest in project.

OPPORTUNITIES

- District energy highlighted as a priority sustainable action strategy in most community energy plans.

THREATS

- System depends on natural gas - current has prices are economically viable.
- General lack of coherent and coordinated policy framework regarding district energy.
- Existing incentive programs target individual small scale systems - this makes it difficult to scale up projects at the community level.
- Legislative barriers, high upfront costs, and complicated approval processes with respect to zoning/permitting.

Case 2: ECamion Energy Storage System + EV Charging

STRENGTHS

- System is estimated to reduce the emission of GHGs by 8000 tonnes a year.
- Energy savings.

WEAKNESS

- General lack of research and development on thermal energy and district energy in Canada.
- Co-op governance structure - requires member interest in project.

OPPORTUNITIES

- District energy highlighted as a priority sustainable action strategy in most community energy plans.

THREATS

- System depends on natural gas - current has prices are economically viable.
- General lack of coherent and coordinated policy framework regarding district energy.
- Existing incentive programs target individual small scale systems - this makes it difficult to scale up projects at the community level.
- Legislative barriers, high upfront costs, and complicated approval processes with respect to zoning/permitting.

Case 3: Pole Mounted Energy Storage

STRENGTHS

WEAKNESS

- General lack of research and development on thermal energy and district energy in Canada.
- Co-op governance structure - requires member interest in project.

OPPORTUNITIES

- District energy highlighted as a priority sustainable action strategy in most community energy plans.

THREATS

- System depends on natural gas - current has prices are economically viable.
- General lack of coherent and coordinated policy framework regarding district energy.
- Existing incentive programs target individual small scale systems - this makes it difficult to scale up projects at the community level.
- Legislative barriers, high upfront costs, and complicated approval processes with respect to zoning/permitting.

Section 4 - Recommendations:

- Analyze CEPs of 12 municipalities in Ontario to guide decision making.
- Make recommendations based on municipal level of interest.
- Conclusion.

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Appendix F: EV Transportation Literature Review

Section 1 - Overview of Sustainable Transportation Planning in Ontario:

In Ontario, there are currently more than 16,000 electric vehicles (EVs) on the road. EV sales grew by 67% last year and will represent 20% of all new car sales by 2030.[244] Statistics show that more than 80% of EV charging occurs at home or at work.[245] The growing number of EVs on the road are supported by a developing EV-charging network.

FLO Canada, a private company that operates a comprehensive electric charging network, provides drivers with more than 2500 charging stations across the country.[246] It is known as Canada's largest EV charging network. Stations linked to FLO's network are connected and monitored remotely for reliability. It also offers smart home charging options for single-family houses and multi-unit residential buildings. The charging stations are also equipped with built-in energy management features that help reduce energy and installation costs for station owners. In Ontario, charging stations are to be installed strategically along the busiest highways and each location is to be equipped with a direct-current fast charger (DCFC) and a dual Level 2 curbside charging station to accommodate all types of EVs.[247] Dual Level 2 curbside charging stations allow most EVs to be charged to their full capacity in 3-4 hours, and is compatible with both EVs and plug-in hybrid cars.[248]

<u>Current policy environment and incentive programs for EVs in Ontario:</u>
The electrification of transportation is highlighted as a priority in Ontario's 2017 Long Term Energy Plan (LTEP). The plan outlines objectives towards developing electric charging infrastructure for low-emission transportation, such as EVs and hybrids. It also lays out guidelines that can help utilities to intelligently and cost-effectively integrate electric vehicles into their grids, including smart charging in homes. The objectives of Ontario's Climate Change Action Plan (2016-2020) fall in line with LTEP's goal to increase

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244 FLO. (2018). "FLO welcomes Ontario's Workplace Charging Incentive Program."

245 FLO. (2018). "FLO welcomes Ontario's Workplace Charging Incentive Program."

246 FLO. (2018). "FLO welcomes Ontario's Workplace Charging Incentive Program."

247 AddEnergie. (2016). "AddÉnergie powered by Natural Resources Canada to expand FLO, its electric vehicle charging network in Ontario". Newswire.

248 AddEnergie. (2016). "AddÉnergie powered by Natural Resources Canada to expand FLO, its electric vehicle charging network in Ontario". Newswire.

the use of EVs, low-carbon trucks and buses, and become a North American leader in low-carbon and zero-emission transportation.[249]

The Electric Vehicle Chargers Ontario (EVCO) program was announced in 2016 and aims to use $20 million in funding to develop a network of 500 charging stations (over 200 Level 3 'fast-chargers' and close to 300 Level 2) for EVs across Ontario at approximately 250 locations.[250] This would make the EVCO network the largest public network of Level 3 stations in Canada. The province is in the process of working with 24 public and private sector partners to create a network of charging stations in cities, along highways, and at workplaces and public places across Ontario. Currently, around 66% of the network has been developed and is in-service. The Ontario Ministry of Transportation (MTO) expects the final 1/3rd of the network to be deployed in the near future.[251]

The MTO Ontario's Electric Vehicle Incentive Program (EVIP) was announced in 2010 and incentives were updated on January 1, 2017 to further support the goals of Ontario's Climate Change Action Plan.[252] The objectives of the program seek to make EVs more affordable and ensure that low carbon vehicles are more strongly supported. EVIP encourages EV adoption, rewards adopters with incentives, and stimulates market demand for more sustainable transportation technology, thereby helping to reducing greenhouse gas emissions from Ontario's transportation sector.

Another incentive program provided by the MTO is the Ontario's Workplace Electric Vehicle Charging Incentive Program (WEVCIP). This provides funding for Level 2 charging stations (which can fully charge most EVs in 5 to 6 hours). FLO Canada currently operates more than 4,000 of these charging stations across the country, providing remote monitoring in real time to ensure reliability and service quality.[253] The program also covers up to 80 % of the cost to purchase and install Level 2 charging stations, and up to $7,500 per charging space.[254]

It is also important to note the The Green ON Funding challenge. This program under the Government of Ontario provides up to $300 million to support the development of low

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[249] Government of Ontario. (2012-2018). Climate Change Action Plan.

[250] Ontario Ministry of Transportation. (2018). "Electric Vehicle Chargers Ontario (EVCO)".

[251] Ontario Ministry of Transportation. (2018). "Electric Vehicle Chargers Ontario (EVCO)".

[252] Ontario Ministry of Transportation. (2009). "Electric Vehicle Incentive Program (EVIP)".

[253] FLO. (2018). "FLO welcomes Ontario's Workplace Charging Incentive Program."

[254] FLO. (2018). "Provide EV Charging at your workplace by taking advantage of WEVCIP."

carbon technologies and sustainable initiatives.[255] The program is focused on projects that identify and implement solutions to climate change issues and implement pilot projects that aim to reduce emissions.

There is also support for EVs at the federal level. The government's 2016 budget provided $16.4M for Phase 1 of the Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative.[256] Upon completion in March 2018, this initial investment is expected to develop over 100 new publicly accessible EV fast chargers, seven natural gas and three hydrogen refuelling stations in seven Provinces. To continue the effort towards electrifying Ontario's transportation network, budget 2017 announced an additional $80M of funding over the next four years for Phase 2 of this Initiative.[257] The development of this infrastructure will enable the Government to complete the coast-to-coast network of EV fast chargers along the national highway system, as well as establish hydrogen stations in major city centres.

Challenges with developing EV infrastructure in Ontario:

Despite the various incentive programs and progress made towards developing EV infrastructure in Ontario, there have been major setbacks and delays. A green energy firm that was contracted $11.4 million to develop 500 charging stations is a year behind schedule and has only installed half of its initial target.[258] In addition, there have also been challenges with implementation due to the difficulties with regards to obtaining permits by public and private sector entities, as the stations are located in various community centres, retail outlets, and other public spaces.[259] Furthermore, there are also technical aspects of installing the chargers and getting them running, addressing different site conditions, municipal permitting, land ownership and electrical grid limitations.

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[255] Green Ontario Fund. (2018). Government of Ontario. Retrieved from: https://www.greenon.ca/programs/greenon-challenge

[256]Natural Resources Canada. (2018). "Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative". Government of Canada."

[257] Natural Resources Canada. (2018). "Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative". Government of Canada."

[258] Yuen, J. (2018). Liberals failed to provide 'proper oversight' on electric car charging program: PC critic". Toronto Sun.

[259] Shazad, R. (2017). Electric vehicle charging network will be only two thirds complete by Friday deadline, province says". CBC News.

Section 2 - Identifying Opportunities for ECB Project:

In identifying opportunities for the ECB project, a review of successful cases of what other co-ops, municipalities, and private developers are implementing elsewhere (primarily in the United States and Europe) was conducted. This phase of the project served to examine the challenges associated with relevant projects, identify the lessons learnt, analyze the regulatory environment, highlight innovative financing mechanisms and governance structures, and finally evaluate the potential to replicate similar models in Ontario. It is expected that the case studies will better inform decision making and provide valuable reference material for moving forward.

In order to gauge the level of interest with respect to key focus areas, an analysis of 22 Municipal Energy Plans (Corporate Energy Plan, Community Energy Plan (CEP), Sustainability Plan, and Climate Change Plans) was conducted. The results indicate that Energy Efficiency, District Energy/ Geothermal, Renewable Energy, and Sustainable Transportation are high priority carbon-reduction measures for municipalities in Ontario. Although it can be deduced that the electrification of transportation is not a "High" level of interest amongst municipalities, it is important to note that most energy-planning documents often focus on alternative approaches to sustainable transportation through comprehensive urban planning. This includes initiatives to develop more active transportation options such as improved biking infrastructure and pedestrian accessibility.

For the **Electrification of Transportation** focus area, the following case studies have been selected for an in-depth review:

Case 1: Electrification of Buses
Case 2: Electrification of Municipal Fleet Vehicles (Ontario)
Case 3: Electrification of EMS Vehicles

These case studies were chosen primarily due to their community focus, innovative approach, value of lessons learnt, and the potential for renewable energy co-ops to replicate similar models in Ontario.

Case 1: Converting Diesel Buses to Electric -

Minnesota co-ops launch electric school bus pilot:
In Minnesota, two power co-ops, Great River Energy and Dakota Electric Association, partnered with a school bus manufacturer in Canada to send children to school in an

electric bus, one of less than 100 currently operating in North America.[260] The project aims to test electric school bus performance in cold weather climates and on longer suburban and rural routes. The eLion bus, manufactured in Quebec by Lion Electric Co., is powered 100% by electricity, seats 72 passengers and has a range of 100 miles per charge. With the average school bus route being around 66 miles according to the National Rural Electric Cooperative Association, this means that these electric buses should have more than enough range to provide service.[261] The cost of the bus was shared equally between Great River Energy, the electric co-op Dakota Electric Association, and Schmitty and Sons Bus Co.[262]

Great River Energy is a power cooperative and the organization's members and owners are 28 Minnesota electric distribution cooperatives. Individuals and businesses are members of those distribution cooperatives based on their geographic location. Great River Energy is part of a nationwide alliance made of more than 750 electric cooperatives in 46 states.

According to Midwest Energy News, The buses will cost $325,000. This is three times the cost of conventional diesel-based school buses. However, it costs around $12,000 annually (approximately $1000 per month) to operate.[263] The average vehicle maintenance and repair cost for conventional school buses is around $14,000 ($1170 per month).[264] This translates to cost savings of about $170 per month, or around $2,000 annually. It is important to note that the maintenance and variable costs of electric buses have been proven to be lower than diesel alternatives, along with an improved energy efficiency.[265] The projected falling costs of lithium batteries will further reduce costs in the near future. There is also the added benefit of improved safety and comfort in the form of better ergonomics and a composite roof to mitigate rusting and leakages. Furthermore, there is no carbon emissions since the bus company is a part of Great River Energy's Revolt EV Program, which charges electric vehicles entirely by wind energy.[266]

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260 Walton R. (2017). "Minnesota co-ops launch electric school bus pilot".

261 Walton R. (2017). "Minnesota co-ops launch electric school bus pilot".

262 Walton R. (2017). "Minnesota co-ops launch electric school bus pilot".

263 Jossi, F. (2017). "Minnesota district to get Midwest's first electric school bus this fall". MidwestEnergyNews.

264 Bus Maintenance Cost Template MSBO. (2011). Bus Leasing Cost.

265 Adheesh, S. Shravanth, V. Ramasesha S. (2016). "Air-pollution and economics: diesel bus versus electric bus". Divecha Centre for Climate Change, Indian Institute of Science.

266 Jossi, F. (2017). "Minnesota district to get Midwest's first electric school bus this fall". MidwestEnergyNews.

The bus will also be charged overnight when electric rates are lower in order to further reduce costs.

Clean energy groups throughout the U.S Midwest, along with several utilities have been advocating the use of Volkswagen settlement funds for electric school buses. The settlement agreement will bring $47 million to Minnesota over the next 10 years and a portion of that funding could be used to add more electric school buses. It is important to note that no subsidies or grants were used or applied for as the objective of the pilot study was to demonstrate that the bus could be self-funded.

Cooperatives serve more than 8,000 of the United States' 13,325 school districts, which means that partnerships like Great River and Dakota Electric's could provide a feasible model for scaling the project.[267] Interest in electric school buses is also growing, with Massachusetts awarding grants to four schools in 2016 to develop carbon-free transportation programs. Also, it should be noted that Great RIver Energy is planning to add two more buses after the pilot project is completed.

Winnipeg:

A joint report from the Province of Manitoba and the City of Winnipeg recommends that the city should electrify its fleet vehicles.[268] As a first step, it is recommended that the city should deploy between 12 and 20 electric buses — between 2 to 3 percent of its total fleet, rather than purchasing new diesel buses. The report indicates that a deployment on that scale would provide enough information to plan for the further integration of electric buses into the system and identify potential risk factors.

Costs:

The report determined that the costs depends on how often the buses would be on the road, with an estimated range between $130,000 and $160,000 more per bus than a diesel unit. This includes the necessary cost of charging equipment.[269] It is important to note that electric buses produce 98 percent less GHG emissions than diesel buses (around 3 kg of emissions per 100 kilometers). With anticipated carbon taxes, Winnipeg transit estimates an additional $1 million extra in costs, thereby presenting a strong case for electrifying buses. Furthermore, with the declining costs for batteries and likely higher costs for diesel fuels (due to carbon pricing effects), electrification of buses would create additional operational savings over the long term.

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[267] Jossi, F. (2017). “Minnesota district to get Midwest’s first electric school bus this fall”. MidwestEnergyNews.

[268] Maclean, C. (2018). “Add up to 20 electric buses to Winnipeg Transit fleet, report recommends”. CBC News.

[269] Aumell, C. (2018). “City should look to add 12-20 electric buses: report”. Global News.

Other Cities worldwide electrifying their bus fleets:

- Shenzhen's transport commission said on Dec. 27 that it had transitioned its 16,359 buses to all-electric models. The city is targeting its fleet of 17,000 taxis next (63% of them are already electric). China initially chose the city as a pilot for implementing electric transit in 2009. It now intends to expand the effort across the nation.[270]
- Los Angeles's Antelope Valley Transit Authority aims to be the first all-electric public transit fleet in the US by buying 85 electric buses over the next five years.[271]
- Seattle is buying 120 new electric buses over the next three years.[272]
- London's black taxis, owned by the Chinese automobile Geely which also owns Volvo, plan to go electric as well.[273]

Case 2: Electrification of Municipal Fleet Vehicles

With the global electric car stock surpassing 2 million vehicles in 2016, the movement towards widespread adoption of EVs is gaining traction.[274] A new record of EV registrations was accomplished that year, with over 750,000 vehicles being sold worldwide. However, it is important to note that the majority of the sales took place in a particular number of countries.

In Canada, EV uptake has been relatively slow. According to a report published by Clean Energy Canada, only 0.59 per cent of new cars purchased in the country were electric.[275] In contrast with Norway, which is often heralded as a world leader in promoting EVs, almost 30 per cent of new cars are EVs. There have been several challenges when it comes to increasing the adoption of EVs in Canada. The three major barriers associated with EVs are: limited range, lack of infrastructure, and costs.[276] Despite various incentive programs and subsidies, investment costs for EVs are typically higher than for conventional vehicles.

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[270] Coren, M. (2018). "One city in China has more electric buses than all of America's biggest cities have buses". Quartz.
[271] Coren, M. (2018). "One city in China has more electric buses than all of America's biggest cities have buses". Quartz.
[272] Coren, M. (2018). "One city in China has more electric buses than all of America's biggest cities have buses". Quartz.
[273] Coren, M. (2018). "One city in China has more electric buses than all of America's biggest cities have buses". Quartz.
[274] Mckenne, C. Olswang, N. (2018). "CMS Guide to Electric Vehicles".
[275] Larsen, K. (2017). "Canada's relationship with electric vehicles needs a boost, says report". CBC News.
[276] Stevens, M. (2017). Electrifying Light-Duty Municipal Fleets in Ontario. Fleetcarma.

However, it is important to note that a forecast cost reported by the Financial Times expects that the gap will be soon closing.[277] The analysis revealed that cost parity between EVs and conventional gas and diesel vehicles will be likely in Europe this year, and the U.S by 2023.[278] In addition, the falling cost of batteries would further reduce the cost of EVs, ultimately leading to increased affordability in the near future. Research analysis indicates that EVs will eventually become cheaper to buy than conventional vehicles in most counties by 2025-2029.[279] Better EV charging infrastructure and planning will also help incentivize Canadians to invest in EVs.

A report by Fleetcarma, a Waterloo-based software company, has shown that when EV fleets are deployed strategically, there can be significant benefits such as fuel cost savings.[280] The environmental benefits in the form of reduced carbon emissions are important to note. A Rotterdam study in cooperation with two private companies has also demonstrated that there can be a significant reduction in carbon emissions and particulate matter when transitioning a fleet of conventional fossil fuel-based vehicles to plug-in EVs.[281]

The cost savings from reduced operations and maintenance of EVs is another important factor to consider. A recent study revealed that electric cars are becoming cheaper to own than conventional cars.[282] Although partly attributed to government subsidies, the maintenance costs were always also found to be cheaper than gas-powered cars. The study also considered depreciation, gas costs, electricity costs, insurance, and tax. The total fuel cost (gas, electricity, or a combination) was found to be the cheapest in plug-in hybrids, but most expensive in gas-powered.[283] Another study from the University of Michigan's Transportation Research Institute has also found that EVs cost less than half as much to operate than traditional cars. The average cost for gasoline-based vehicles is $1,117. In contrast, the average cost to operate an EV in the United States is around $485 per year, thus yielding $632 in savings annually.[284] These findings have major implications

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[277] Mckenne, C. Olswang, N. (2018). "CMS Guide to Electric Vehicles".

[278] Winton, N. (2017). Electric Car Price Parity Expected Next Year - Report. Forbes.

[279] Mckenne, C. Olswang, N. (2018). "CMS Guide to Electric Vehicles".

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[281] Solutions Factsheet. "Electric vehicles in municipal fleets". Urban Mobility EU.

[282] Joseph, R. (2017). "Reality check: Are electric cars cheaper to own than gas-powered cars?". Global News.

[283] Palmer, K. Tate, J. Wadud, J. Nellthrop, J. (2017). Total cost of ownership and market share for hybrid and electric vehicles in the UK, US and Japan. Applied Energy. Science Direct.

[284] Palmer, K. Tate, J. Wadud, J. Nellthrop, J. (2017). Total cost of ownership and market share for hybrid and electric vehicles in the UK, US and Japan. Applied Energy. Science Direct.

for building a viable business and environmental case for electrifying municipal fleet vehicles.

The benefits of electrifying fleet vehicles have prompted cities around the world to adopt EVs. The City of Vancouver currently has the largest municipal electric vehicle fleet in Canada. Its Greenest City Action Plan outlines initiatives to meet its fleet emissions target which is 30 percent of 2007 levels by 2020. The city has been in correspondence with electric vehicle manufacturers to increase the number of its medium and heavy-duty electric trucks.[285] It signed a contract with Mitsubishi Fuso for six electric medium and heavy-duty trucks to be delivered in 2018. Its ultimate goal is to replace 100 of its gasoline-based vehicles within the next few years.[286] There are currently 70 charging stations across Vancouver, which are owned by the city. In order to expand the existing EV infrastructure network, the City has the goal of having 25 DC Fast Charging locations and 50 additional Level 2 stations by 2021. Currently, the city requires at least 20 percent of parking spots in new developments to be equipped with EV charging infrastructure.[287] Also important to note is the city's recently announced 'curbside EV charging' pilot program for commercial businesses and single-family homes.[288]

Case 3: Electrification of EMS Vehicles

In 2016, BMW introduced a series of EVs called i3 Emergency Vehicles that have functions that are specifically designed for the requirement of emergency services.[289] Authorities in Bavaria, Milan, Los Angeles, and London added these EVs to their emergency fleets in 2015.[290] These vehicles feature innovative design elements such as special signalling systems and permanently-installed SIM cards that enable the use of intelligent networking technology. Called the 'Connected Rescue system', it enables control centres to transmit important information such as addresses, assignment details, and target coordinates. This information can automatically update the navigation system's route

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[285] Puri, B. (2017). "Vancouver looking to increase number of medium and heavy-duty electric trucks". CBC News.

[286] Puri, B. (2017). "Vancouver looking to increase number of medium and heavy-duty electric trucks". CBC News.

[287] Ip, S. (2018). Vancouver council to vote on bylaw requiring all new builds to be equipped with electric vehicle charging. Vancouver Sun.

[288] Ip, S. (2018). Vancouver council to vote on bylaw requiring all new builds to be equipped with electric vehicle charging. Vancouver Sun.

[289] Boeriu, J. (2016). "BMW i3 Emergency Vehicles displayed at the BMW Welt". BMW Blog.

[290] Boeriu, J. (2015). "BMW i3 now available for police forces, rescue services and fire departments". BMW Blog.

guidance, thereby negating the need for manual inputs and improving the safety and efficiency of rescue forces.

The London Fire Brigade purchased 52 ultra-low emission BMWi3s in 2016, with plans to purchase electrics and hybrids in the near future.[291] The vehicles are used for fire services and for emergency-related incidents across the city, averaging approximately 7000 miles a year. Although the hybrid cars are equipped with both an electric and gasoline-powered engine, it is important to note that officers using the cars have reported barely having to use gasoline.[292] In addition, the vehicles can be charged at 73 fire stations across London and the battery can even be charged while driving by a gas-powered generator. The City of London has made progressive strides towards stimulating demand for EVs and it is estimated that there are approximately 80,000 electric cars on its roads. Furthermore, the city pledged more than £600m to support the EV industry up until 2020. This includes funding for almost 180 EVs being used by emergency services, hospitals and councils as part of its goal to make all its vehicles emission free by 2050.[293]

Transitioning gas-powered emergency vehicles to EVs can potentially lead to significant benefits for communities. In a report published by the U.S Department of Energy on police vehicle fuel consumption, cruisers were found to idle 60% of the time during regular operations and used 21% of its total fuel while parked.[294] With respect to fire department vehicles, only 20% of dispatch calls are for fires, while most are for medical emergencies or accidents. For all calls, vehicles are often idled to provide power for emergency lights and accessories.[295] In the case of ambulances, engines are often idled in order to sustain lighting, communications and medical equipment, computers, heating and cooling systems, and for life support apparatus. In addition to wasting fuel, idling gas-powered engines can contribute to significant air pollution and can worsen health conditions in sensitive populations.[296]

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[291] London Fire Brigade. (2016). "Brigade first in London to turn all blue light cars 'green'". Government of UK.

[292] London Fire Brigade. (2016). "Brigade first in London to turn all blue light cars 'green'". Government of UK.

[293] London Fire Brigade. (2016). "Brigade first in London to turn all blue light cars 'green'". Government of UK.

[294] Energy Efficiency and Renewable Energy. (2015). "Idling Reduction for Emergency and Other Service Vehicles". U.S Department of Energy.

[295] Energy Efficiency and Renewable Energy. (2015). "Idling Reduction for Emergency and Other Service Vehicles". U.S Department of Energy.

[296] Energy Efficiency and Renewable Energy. (2015). "Idling Reduction for Emergency and Other Service Vehicles". U.S Department of Energy.

Replacing conventional gasoline-powered emergency vehicles can lead to reduced emissions and fuel savings. EMS vehicles are often locally dispatched and as mentioned, acquire prolonged idling times. Switching to EVs would allow EMS fleets to reduce the associated emissions (and fuel costs) stemming from this issue. In addition, because EMS vehicles are typically dispatched locally, there is ample time for charging at hotspots as they wait for calls. Charging systems can be installed near emergency rooms at hospitals to enable ambulances to plug in for power. A U.S Department of Energy report even recommends solar panels that can be installed on roofs to provide additional power.[297]

Section 3 - Determining Feasibility for Implementation:

Case	1) Electrification of Bus fleet - Minnesota Co-op	2) Electrification of Municipal Fleet Vehicles	3) Electrification of EMS Vehicles
Interest in Ontario for Implementing Similar Project	✓	✓	?
Conducive regulatory environment in Ontario	✓	✓	
Dedicated funding sources	✓	✓	✓
Does not require external funding			
Challenges with implementation	✓	✓	✓
Financially Viability	?	?	?
Potential municipal/coop partnership			

[297] Energy Efficiency and Renewable Energy. (2015). "Idling Reduction for Emergency and Other Service Vehicles". U.S Department of Energy.

Can a RE Co-op/Municipal partnership replicate this model?

Case 1: Electrification of Buses

STRENGTHS

- Lower fuel costs - powered by wind energy (Great River Energy).
- Lower ownership costs: operations and maintenance ($2000 in savings annually).
- Improved energy efficiency.
- Reduced carbon emissions.
- Improved safety and comfort.
- Better quality.

WEAKNESS

- High initial capital investment (electric buses cost = $325,000 each)
- Ownership model (who will own the electric buses - coop/municipality/bus operator)

OPPORTUNITIES

- Various funding programs available (Ontario Climate Change Action Plan, GreenON fund, etc.)
- The use of electric school buses is growing in jurisdictions, including California and Quebec, with about 100 electric school buses currently in use in North America.
- Ontario is investing $8 million this year for the Electric School Bus Pilot Program (applications ended Oct 2017) - data collected on the performance of the electric school buses will be used to develop a business case for their adoption by school bus operators, and also examine their potential within student transportation to reduce greenhouse gas emissions and improve air quality.
- Government of Ontario. (2017). "Ontario Fighting Climate Change with New Electric School Buses."

THREATS

- Regulatory Environment with respect to operating bus networks in Ontario.
- Co-op governance structure - requires member interest in project.
- Financial viability - question of suitable revenue stream.

Case 2: Electrification of Municipal Fleet Vehicles (Ontario)

STRENGTHS

- Lower fuel costs and carbon emissions.
- Lower ownership costs: operations and maintenance lower for EVs (average cost to operate EVs in the U.S is ~ $485 per year - yielding $632 in savings annually)
- Cost parity between EVs and conventional gas and diesel vehicles is expected to be soon
- Improved energy efficiency.
- Public health benefits.

WEAKNESS

- High capital costs - EVs typically more expensive than conventional gasoline cars for the time being.

OPPORTUNITIES

- Various funding programs available (Ontario Climate Change Action Plan, GreenON fund, etc.)
- In Canada, EV uptake has been relatively slow.

THREATS

- Co-op governance structure - requires member interest in project.
- Ownership viability - who will own the vehicles in a municipal/co-op partnership
- Financial viability - question of suitable revenue stream.

Case 3: Electrification of EMS Vehicles

STRENGTHS

- Lower fuel costs and carbon emissions (EMS vehicles have significant idling times)
- Lower ownership costs: operations and maintenance lower for EVs.
- Cost parity between EVs and conventional gas and diesel vehicles is expected to be soon
- Improved energy efficiency.
- Public health benefits.

WEAKNESS

- High capital costs - EVs typically more expensive than conventional gasoline cars for the time being.

OPPORTUNITIES

- Various funding programs available (Ontario Climate Change Action Plan, GreenON fund, etc.)
- In Canada, EV uptake has been relatively slow.

THREATS

- Co-op governance structure - requires member interest in project.
- Ownership viability - who will own the vehicles in a municipal/co-op partnership
- Financial viability - question of suitable revenue stream.

Section 4 - Recommendations:

- (Pending workshop with municipalities for feedback and review)
- Reflect on CEP analysis of 22 municipalities across Ontario to guide decision making.
- Make recommendations based on municipal level of interest.
- Conclusion.

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